THE

ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

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H. ALABASTER, GATEHOUSE & CO.,

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COMMERCE AND CABLES.

THE address to the Associated Chambers of Commerce, which was recently delivered by Sir Edward Sassoon, affords us assurance, if such were necessary, that the subject of efficiency, combined with economy in our means of communicating by telegraph, has in no way lost its interest for the commercial community of the United Kingdom. Although in some respects, and this largely in consequence of the action of the Parliamentary Cable Committee, of which Sir Edward Sassoon is chairman, a degree of improvement has recently been brought about, principally in the reduction of rates to Australia, yet a perusal of the address, which we reproduce elsewhere, cannot fail to convince our readers that there is still very much to be done. It is to be hoped that the Inter-Departmental Committee now sitting with Lord Balfour as chairman, to inquire under wide terms of reference, into questions affecting the working of the cable communications of the world, will hold a most thorough and searching inquiry, which cannot fail to bring to light some of these matters that remain hidden away in the agreements affecting many of these telegraph companies; agreements not only existing between the companies themselves, but also between the companies and various Governments.

The position in which India stands in relation to some of the existing companies was dwelt upon at some length in the speech in question, and certainly deserves all the attention that was bestowed upon it. This is a subject to which we have from time to time referred, and we are glad to see it is now under investigation.

Let us state the case briefly. It has never, as far as we can gather, been alleged that India pays a direct subsidy to the cable companies with which she has to deal, but there is no doubt that large sums of money have been paid away by India for the benefit of these companies, in a way for which it is difficult to find any justification; especially when it is borne in mind that the sacrifices thus made by India were quite uncalled for. To quote Sir Edward Sassoon's words:—

> In 1891 pressure was brought to bear by the Australian Government on the companies for the lowering of rates to Australia, which then stood in the neighbourhood of 9s. 4d. per word. The companies urged the Indian Government to help them in making this reduction; this was done; the Indian "transit" charge was reduced by 50 per cent., from 7d. to 3½d. Not content with this very substantial concession, the Indian Government must needs enter into a "pooling" account, the result of which has been that on this account alone India has paid in £46,000 more than she has taken out. Mark you, that this route across India is the only practical route for the transmission of such messages; and, therefore, India had the whip hand, thus while the public has been groaning under the admittedly intolerable burden of the 4s. rate to India—which has been maintained since 1886—we find the Indian Government in 1891 going out of their way to needlessly expend for the benefit of Australia, money which should have been applied for the benefit of Indian messages.

In the above it is only the £46,000 lost in the "pooling account" that is mentioned, but no figure is given as the amount lost to India owing to her unnecessary reduction of

the transit rate. As far as can be gathered from the imperfect official returns, this sum cannot be much less than £450,000 for the last nine years. But beyond this, there is still another "pooling arrangement" dating from as far back as 1878, which has resulted in a loss to India of over £200,000 more. It may well be considered that these agreements should be strictly investigated, as we have shown that India has gratuitously thrown away some £700,000 for the benefit of these companies, who on their side have done little or nothing to merit any such treatment. Indeed, the Indian Government has great cause of complaint, for although in May last Mr. Hanbury informed the House of Commons: "That everywhere—I believe without exception—wherever these cables run, the British Government not only has priority, but also sends messages at half rates." Unfortunately there is an exception, and as may be judged, considering the way in which she is dealt with in other matters, that exception is India. It was recently explained by the Financial Secretary for the Treasury that State telegrams are carried by these companies at reduced rates, generally half rates for almost every Government in the British Empire, but on the same occasion it was also pointed out by the Secretary of State for India that both the United Kingdom and India pay these companies full rates for Government messages passing between them. It is therefore the case that in spite of the generous treatment which these companies have received, they charge the Indian Government the full rate of 4s. per word for State messages exchanged between India and England. This means an out-payment by both countries of something like £400,000 more than would have been expended had these companies dealt with State messages to and from India in the same way as they dealt with messages sent by almost every other Government. Beyond all this there is also the f ct that since 1876, when the charge for a telegram between England and India was fixed at 4s. 7d. per word, there has been practically no attempt, as the small reduction to 4s. in 1886 could hardly be expected to affect the position, we fairly may say, no real attempt, to foster or encourage Indian traffic by reducing the charges for commercial and social telegrams. Thus we find that while telegraph rates have been reduced all round during the last 25 years—in the case of Australia from 10s. 8d. to 3s. 6d., with a prospective reduction of 2s. 6d. per word—the rate to India has been kept practically stationary, and in return for such treatment, she has allowed herself to be beguiled into squandering a sum almost sufficient to have provided her with a cable of her own to England, for the benefit of these companies who have so pointedly neglected Indian interests.

One of the ideas brought prominently before the meeting of the Chambers of Commerce was that of the possible ultimate State purchase of the submarine cables which link together the scattered fragments of our Empire. This subject we may say is no new one: it is more as a matter of degree, or on account of the considerable expense entailed, that it now arouses attention. It may not be generally known that for many years the numerous short cables which unite Great Britain with the Continent, with France, Holland, and Germany, have been State-owned. In these cases, where the cables starting from the United Kingdom are landed on foreign territory, an arrangement has been arrived at by which the two countries concerned divide the cost of maintenance, and also the cost of laying new cables when necessary. This goes to prove that there is no necessity, as has been alleged, for the intervention of private companies to act as "buffer States" between the various Governments concerned. But in the majority of cases relating to existing long cables, and those which it is suggested should be laid, there would be no foreign State to deal with, as the landings would be entirely on territory belonging to the Empire.

To some extent the advent of State ownership, as applied to long cables, has been anticipated, as witness the Pacific cable, and also the option of State purchase provided for in the agreement made between the Secretary of State for the Colonies and the Eastern Extension Telegraph Company in the case of the Hong Kong to Singapore cable; here, it is true, the clause giving the Government the right of purchase, provides that whatever the age of the cable may be, it is to be paid for at the same rate as if it were quite new; but the principle in question is admitted. The numerous cases of subsidies granted by Government in respect of various cables also have a bearing on this question. In several of these instances it would have been a very profitable investment, apart from the benefits to be derived by the public from Government control, had the amounts given as subsidies been devoted by the Governments in question to paying interest and providing a suitable sinking fund on the capital sum required for the establishment of such lines. It is clear that the difference between the low rate of interest at which Governments can borrow money on the one hand, and the high dividends paid, the large reserve funds stored up, and the laying of additional cables in other districts out of revenue, as practised by private companies, on the other hand, would more than admit of great reductions being made in the rates charged, to the great advantage of our commerce, and therefore in a resultant benefit to the State.

The Diesel Oil Engine.—On Monday, March 25th, a party of engineers and others interested in the development of the oil engine, proceeded to Manchester by invitation of the Diesel Oil Engine Company, to witness the performance of the first Diesel engine constructed in England. This engine has been a good deal used in Germany, and we understand that the company is engaged in its manufacture in the United States. It has also been reported upon by such authorities as Lord Kelvin, Prof. Cawthorne Unwin and Prof. Meyer, of the Technical High School, Charlottenburg. A special train conveyed the party by the Great Central route to Guidebridge, near Manchester, the engine being erected at the works of Messrs. Scott & Hodgson, which practically joins the Great Central at Guidebridge. A 20-B.H.P. Diesel engine of the horizontal type was at work driving a portion of the shop shafting and a few machine tools. Some new features have been introduced in the engine, and Messrs. Scott & Hodgson are making considerable mechanical modifications with a view to the improvement of the engine from a practical standpoint. In the evening the visitors were the guests of the Diesel Engine Company at the Albion Hotel. We shall refer to this engine more fully in our next issue, and in the meantime we must express our appreciation of the courtesy extended to us by the Diesel Oil Engine Company.

LARG GAS ENGINE PRACTICE AT COCKERILL'S WORKS, SERAING.

By E. KILBURN SCOTT, A.M.Inst.C.E.

The writer has recently visited the famous John Cockerill Works at Seraing, where he had the pleasure of seeing what was being done in large gas engine practice. Recent articles in the Electrical Review and elsewhere almost read like a fairy tale, and yet it does not appear that the case for the gas engine has been a bit overstated. A few years ago—one might almost say a few months ago—it was easy to find engineers who would solemnly dogmatise that gas engines were all right for powers up to, say, 40 or 50 H.P., but that for anything larger they were quite unsuitable, particularly for such a purpose as the driving of alternators. This idea seems to have become almost a rooted conviction in this country, assisted, no doubt, by certain unfortunate experiences in connection with the use of gas engines for public electric lighting.

It is a good sign, however, that the technical Press of this country is giving so much attention to the subject, and although English engine makers appear to be still only lukewarm, it is significant that such a firm as Messrs. Willans and Robinson should be moving in the matter.

As with most new industries, the manufacture of the gas engine was at first in the hands of inventors and amateurs, who naturally gave more attention to the development of novel features than to sound mechanical design. The work which the writer saw at Messrs. Cockerill's establishment could certainly only be effectively carried out by the *very largest* engine-making firms. In Germany alone three firms have taken out licenses from the Cockerill Company to manufacture their improved Delamere-Debouteville gas engines, and altogether they and their licensees have about 80 engines of 500 H.P. and over on order at the present time, this including three of 1,200 H.P. each for a Lorraine iron works, the furnaces of which have a daily output of 500 tons of pig iron. Designs are also completed for the 2,500 H.P. size, and it will probably be put in hand shortly.

One thing which struck the writer in going through the erecting shop was the exceeding simplicity of the gas engine as compared with the modern steam engine. This is due primarily to the fact that in order to attain to any degree of economy the steam engine must have a *multiplication* of cylinders. Another reason is the absence of piston rod and cross head in the gas engine, whilst on account of the valve motion being driven by levers and roller cams, practically all packing and glands are dispensed with. The cylinder is unlined, but every care is taken to cut ample oil channels, piston rings are numerous, but they are simply of cast-iron sprung into place.

It might be thought that the metal of the cylinder would be attacked by the gas, but this is not so, as the interior surface of the firing chamber and pipes becomes coated with a thin layer of material which acts as a protection. The wearing surfaces are of course taken care of by an ample supply of oil, and with the present perfect knowledge of lubrication and the use of mineral oil, sticky pistons which were so troublesome in the old days are unknown.

The electric power station at the Cockerill works is being reconstructed, and two 700-H.P. engines are being erected for driving dynamo machines direct. The original gas engine driving a multipolar dynamo by belt, which has been illustrated in so many papers, has run night and day since October, 1898. It averages 21 hours a day, which would be pretty good running even for a steam engine. The blowing engine shown at the Paris Exhibition is now being erected at Messrs. Cockerill's works, and a sister engine is being constructed to go down alongside it.

The original blowing engine (identical with the one at Paris) which has been running most successfully at Seraing since November, 1899, is now at work at a Luxemburg iron works. An illustration of this engine was given in the Electrical Review, June 8th, 1900; the leading particulars are as follows:—

Diameter of gas cylinders	51 in.
„ „ air „	67 „
Stroke	55 „
Number of revolutions per minute	80

The indicated horse-power is 700, equivalent to 550 effective H.P. in compressed air delivery at a pressure of $6\frac{3}{4}$ to $7\frac{3}{4}$ lbs. per square inch. In March of 1900, a very exhaustive series of tests was carried out by Prof. Herman Hubert, and it was established that under normal conditions the consumption of gas was—

111·4 cubic feet per effective horse-power hour.
90·36 „ „ „ indicated „ „

whilst the best result was as low as—

101 cubic feet per effective horse-power hour.
82 „ „ „ indicated „ „

the calorific efficiency of the gas per cubic metre being about 950 calories.

The thermal efficiency or ratio between the power developed and the heat of combustion is 30 per cent., the balance being the heat carried off by the water jacket, 50 per cent., and by the escaping gas, 20 per cent.

Considering that the best efficiency obtained in ordinary steam engine and boiler practice is only 6 per cent., it will be seen what an immense advance is possible.

One extremely interesting result of the development of the large gas engine is that it becomes possible to carry out industrial operations in situations which were before impossible. Thus M. Adolphe Greiner, who, as director-general of the John Cockerill Company, has done so much to forward the development of large gas engine practice, says:—

"There are some works which could not have been established if the invention had not been brought into effect. I may mention the blast furnaces at Toula, in the neighbourhood of Moscow, in a situation where water is entirely absent, and a still larger works in the island of Elba under identical circumstances. The furnaces in this island, where fresh water is non-existent, will require three 600-H.P. blowing engines and three gas motors for electric plant of 200 H.P. each."

Whilst Messrs. Cockerill prefer to make the single-crank engine, they also build them two-crank (as in a cross-compound engine) the alternator or dynamo being carried direct on the engine crankshaft. As it happens, the latest type of alternator, in which the poles are bolted on to the inner periphery of the fly-wheel, enables the rim of the latter to be made of great weight without any trouble, and this and the use of heavy copper bands round or through the pole faces (amortisseurs) should go a long way towards doing away with any difficulty in running alternators in parallel. Of course, for electrical work the gas is mixed, and fires at every fourth stroke, whatever the load. It is only for blowing purposes where regulation of speed is quite unimportant that the old-fashioned hit-and-miss idea is employed.

The only trouble Messrs. Cockerill have had with the engines has been in a particular case where the blast furnace gas carried over a good deal of gritty dust. At Seraing the gas comes away comparatively clean, so that there is no trouble, but in any case when excessive dust does occur, it only means that a little more care must be taken in cleaning the gas before admitting it to the engine. For an electric power station there would be no question of dust or tar in the gas. Either the Mond process as employed at Winnington, the producer method of Mr. Thompson, Glasgow, the Duff process (Granite City Steel Company's Works, Illinois), or some similar process would be used to abstract the ammonia and other bye-products, and so the full value of the coal would be made use of instead of it being wasted in boiler furnaces. Of course, it is only when dealing with very large plants that it pays to put down the apparatus required to remove sulphate of ammonia, &c.

When considered for the purpose of supplying power for electric transmission stations the details of the producer are almost as important as those of the engine; in fact, one of the reasons why in some cases unsatisfactory results have been attained with gas producers, has been because the attendance on a producer is such an unpleasant job that the fuel has not been fed regularly. It is quite important that the feed should be taken out of the hands of the attendants as much as possible, and this, of course, is, after all, an easy matter by the use of elevators, creepers, &c.

DEPRECIATION.

We do not by any means begrudge Mr. Boot the necessary space in our "Correspondence" columns for exhaustively discussing the Tunbridge Wells electricity accounts, because we find that the more they are examined the greater is the need of further explanation.

Mr. Boot appears to admit that a renewal fund is necessary at 2·83 per cent.—for the period of the loan—viz., 25 years, provided the plant is kept in perfect repair out of current revenue.

With the aid of this fund, which would be entirely distinct from the redemption of stock and repayment of mortgage, the depreciation and renewals of plant would be provided for, if the basis he assumes is correct, of 2·83 per cent. being a sufficient amount.

If this is really what Mr. Boot means, there is not much difference in principle between us; but unfortunately his accounts do not carry his views into effect, and if they did they would dispose of any idea of the undertaking having been financially successful.

Mr. Boot disputes our conclusions from Sir David Salomons' advice, and states that the reserve fund of 5 per cent. was intended to provide for any "serious mishap" which might interfere with the profits for that year.

The words attributed to Sir David Salomons in the report of the meeting, from which we quoted, were the following:—"Sir David Salomons advocated the formation of a depreciation or reserve fund in connection with the electric lighting works. He thought that they should lay aside a sum equal to 5 per cent. on the capital outlay upon machinery, mains, &c., out of which all renewals in successive years could be paid."

Then, with regard to the 4 per cent. fixed by the Glasgow Corporation, Mr. Boot explains that it was adopted to make up for previous years when they did not provide sufficient for depreciation. We think Mr. Boot should give his authority for this definite statement.

In our article of 1st inst., we set out in detail the basis upon which the 4 per cent. was fixed, and certainly there was no intimation that the various items, such as land and buildings, 1 per cent.; mains, 2½ per cent.; accumulators, 10 per cent., &c., were not intended as the rates considered fair for a depreciation and renewals account without reference to the provision in previous years. We take it that in the opinion of the Glasgow Corporation 4 per cent. is the proper calculation, and that it will be adhered to.

We can quite understand Mr. Boot having in his mind "unforeseen contingencies," for the following paragraph in the last report of the borough accountant of Tunbridge Wells foreshadows heavy additional charges upon the revenue. He says:—"There is also a further loan contemplated of £10,000 to carry out Sir Wm. H. Preece's report on the smoke and vibration question. This will entail a further burden, amounting to £575 in all, based upon similar assumptions to the previous loan, making an additional annual burden of £2,011 to be borne by the electricity works account, or in default by the general district rate."

Mr. Boot shifts the responsibility of keeping the plant of a company in good order and repair from the engineer to the Board of Directors, and in doing so uses a remarkably strong argument against corporation management of these matters, when he considers that it is human nature for a municipal committee to deal with *money which is not their own*, differently from the directors of a company who economise expenditure. All that the Tunbridge Wells Committee have spent upon repairs and maintenance of their plant during the five years, amounts to £539 7s. 3d., which appears, on the face of it, to be by no means extravagant. As a matter of fact, true economy is to spend what is necessary, and those who understand the business are the best judges in the matter.

Mr. Boot asks us three questions in conclusion.

1. What do you consider the sinking fund provided by a municipal authority is meant to cover?

Answer.—Repayment of loans.

2. As you do not consider the sinking fund should form part of the depreciation fund, why don't you think companies should form a sinking fund as well?

Answer.—The capital being permanently provided, no provision is necessary for repayment.

3. Do you consider any corporation or company setting aside less than 4 per cent. per annum to cover depreciation, in an unsound condition?

Answer.—We contend for the principle of providing a fund for depreciation and renewal, without which we should consider that the accounts are not properly kept. As to the percentage, that is a matter upon which experts differ. The Glasgow authority thinks 4 per cent. a proper amount. Sir David Salomons suggested 5 per cent. Mr. Hammond valued the Eastbourne plant as scrap at the end of 15 years, and Mr. Boot fixes 2·83 per cent., but where, as in the case of Tunbridge Wells, nothing whatever is provided for depreciation and renewal, we contend with the worthy alderman, notwithstanding the shortcomings of his gas company, that "the statement of profit was fallacious."

There are one or two points upon which Mr. Boot might give us a little information, as we cannot find it in the published accounts. He says that they have carried forward every year a sum of about £2,000 instead of transferring it to a "reserve fund." This would amount to, say, £10,000 in the five years. Where does it appear in the accounts?

In the accounts for the year ending March 31st, 1900, the auditor has charged for the first time "a fair proportion of the general salaries and establishment charges," amounting to £250. This is in addition to the rectification made in the 1899 accounts, when the electrical engineer's salary was charged to revenue account, instead of 75 per cent. of it being debited, as in former years, to capital account, contrary to the rule of the Local Government Board.

Will Mr. Boot tell us if these corrections will be made in all the accounts, from the commencement of the undertaking, so as to show precisely what the actual results are?

Our contemporary *Lightning* appears to be under the impression that Mr. George Offor is in some peril from which we have chivalrously endeavoured to rescue him, and in supporting his view that repayment of a loan for providing electrical plant does not cover depreciation and renewal, we have got out of our depth.

We are delighted to agree with *Lightning* in admitting, what we never denied, that a local authority is entitled to re-borrow—when a loan has been repaid; but is it necessary to point out to our enlightened contemporary, that the reproduction of its depreciated property by borrowing the capital over again is rather a curious way of securing the valuable asset which municipal traders in electricity supply assure us is the result of the sinking fund?

The amount of the depreciation and renewal fund is, of course, involved in the question of the life of the plant, but the provision of such a fund cannot be dispensed with by the proposal to borrow over again, instead of providing for it out of revenue. This is the practice which we contend is bad finance.

CURRENT SPECIFICATIONS.

LIV.—HORNSEY ELECTRIC LIGHTING.

Summary.

Extent of Contract.—Supply under different sections, of the plant required for a complete electricity supply system, with the exception of all pipework, the specification for which section will be issued later.

Proposed System.—Three-wire low tension system, with a voltage of 480 volts between the outer conductors and 240 volts between inner and either outer.

Type and Size of Boilers.—Three to be supplied of "Dryback" type, each capable of evaporating 8,000 lbs. of water per hour for 10 consecutive hours, feed water temperature 60° F.

Working Pressure.—155 to 180 lbs. per square inch.

Type of Feed Pumps.—To be two in number, each of Weir type, capable of pumping 24,000 lbs. of water per hour against a boiler pressure of 180 lbs. square inch.

Size and Type of Economiser.—To be "Green's" pattern 96-tube size.

Size and Type of Engines.—Two to be supplied, vertical triple-expansion type, two or three-crank, each capable of driving at full load a 300-kw. dynamo.

Specified Speed.—Not to exceed 440 revolutions per minute.

Type of Dynamos.—To be shunt wound, with pole-pieces arranged to allow of easy inspection of armature without dismantling machine.

Range of Voltage.—Under normal conditions 480 to 550 volts, but capable on emergency of working at 640 volts for cell charging at increased speed.

Specified Overload of Sets.—10 per cent. for two hours' continuous run.

Permissible Temperature Rise.—60° F. above surrounding atmosphere after 10 hours' run at normal full load.

Stipulated Steam Consumption.—26 lbs. per KW.-hour working, condensing 24 in. vacuum, 150 lbs. square inch steam pressure, ordinary dry steam.

Capacity of Motor-Transformer.—One to be supplied consisting of motor wound for 480—540 volts, direct-ccupled to dynamo capable of developing 150 amperes at any voltage between 20 and 160 volts.

Capacity of Balancing Motor Transformer.—To be suitable for dealing with an ordinary out-of-balance current of 100 amperes, and on emergency 130 amperes.

Type of Condensing Plant.—Surface condensing, the air and circulating pumps being steam driven, independently of the steam dynamos.

Capacity of Condensing Plant.—Ordinary duty 15,000 lbs. of steam per hour, emergency duty 20,000 lbs. per hour.

Type of Water-Cooling Plant.—Left to tenderer, the duty and normal conditions of working being specified.

Type of Switchboard.—To be in accordance with specification, suitable for use on a three-wire direct-current system having the dynamos wound for the voltage across outers, a balancing transformer and a battery of cells.

Capacity of Cells.—Complete battery to be capable of maintaining a discharge of 120 amperes for 10 hours without terminal voltage falling below 540 volts.

Stipulated Period for Maintenance of Battery.—Twelve months free, thereafter at annual payment to be stipulated by tenderer, to its full capacity for a term not exceeding 14 years.

Size of Crane.—To be capable of lifting 10 tons, and suitable for a span of 38 ft. 6 in.

Types of Cables.—To be of specified lengths, laid as directed in scheduled thoroughfares. Distributors to be triple concentric; feeders ditto; house service mains, simple concentric, steel armoured; arc lamp cables, single cables; and pilot wires, three-core.

Method of Laying.—On solid system, in earthenware conduits, or, where crossing streets, in iron troughing.

Number of Public Arc Lamps.—One hundred, liable to alteration as work proceeds by 10 per cent. either way.

System of Arrangement.—To be placed five in series across 240-volt mains.

Type of Lamps.—To be single-carbon, 10-ampere, 17-hour lamps.

Value of Post.—Not to exceed a tendered value of £14 per post complete and erected.

Number of Meters.—450 in all required, of various sizes, to be suitable for direct currents 240-volt circuit, to read direct in watt-hours.

Specified Dates of Completion.—Various dates for the different sections are given, largely dependent upon the date of completion of the building, but the contractor for the steam dynamos can, at his option, take 10 months from date of order.

Penalty for Late Completion.—During first month one-quarter of 1 per cent. per week, during second month one-half of 1 per cent., during third month three-quarters of 1 per cent., and during fourth and subsequent months 1 per cent. per week.

Specified Times of Payment.—Eighty per cent. of contract sum for each section as work proceeds on site, 10 per cent. one month after plant has been taken over, 10 per cent. nine months afterwards. In the case of several small sections these terms are slightly modified.

Specified Period of Maintenance.—Until final payment is made against faults due to defective workmanship and material.

Stipulations as to Wages Paid to Workmen.—None.

Stipulations as to Removal of Foreman.—Satisfactory.

Arbitration Proposal.—Satisfactory.

Date for Receipt of Tenders.—April 11th, 1901.

Mr. Robert Hammond, M.I.C.E., is responsible for the drafting of this specification in his capacity of consulting electrical engineer to the Hornsey Urban District Council. The above summary will give a fair idea of the complete manner in which the details of the proposed system have been worked out. Contrary to the practice in some of Mr. Hammond's recent stations, the main dynamos are both wound for the voltage between the outers, and the battery and a balancing transformer are depended upon to deal with the out-of-balance current.

As usual in Mr. Hammond's specifications, the stipulations as regards tests are very onerous, a six-hour run of the steam dynamos being required at the maker's works, as well as the steam consumption tests after erection at Hornsey.

A steam consumption under specified conditions of 26 lbs. per KW.-hour is demanded. If this amount is exceeded, a penalty *pro rata* of *£200* for each excess pound of steam will be inflicted, but for all improvements below 25 lbs. per KW.-hour, a bonus at a corresponding rate will be paid.

The general conditions are on the whole very satisfactory, and affords another example of the manner in which the practice of leading consultants is approximating to a standard mutually acceptable to purchasers and contractors.

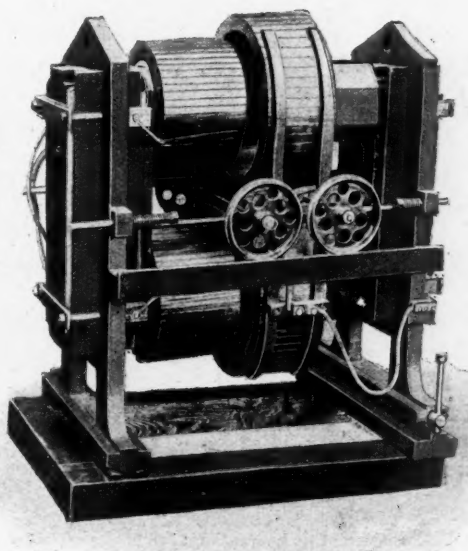
The arbitration clause is unlimited in its operation, there are no penal clauses regarding the conditions of labour, and detail drawings are expressly not required until after the contract has been awarded. Great stress is laid upon the decisions as to details arrived at at an interview to take place within one week of the signing of the contract.

One of the clauses regarding maintenance is not likely to meet with universal approval, as a guarantee against defective materials, design, or workmanship, or carelessness in laying is demanded for the cable section for a period of *five years* from the date of completion of the work. This is distinctly contrary to the expressed wish of the cable makers who are desirous of limiting, as far as possible, their liability to maintain for long periods after completion.

NSTANT CURRENT SERIES ARC LIGHTING.

A NEW system of arc lighting was devised by the Gilbert Arc Lamp Company, and installed at Harrogate about a year ago, which seems to possess in many respects considerable advantages. Circuits of about 12 of the company's open type long-burning arc lamps are supplied from special moving coil constant current transformers; the number in series is limited only in order to make the employment of high pressure unnecessary. The transformers are put underground, and left for long periods without attention, and the switching on is done at a distance.

Few English engineers seem to realise that even short series of



CONSTANT CURRENT TRANSFORMER.

lamps are, on the whole, much more satisfactory, and give less trouble, than independent alternating current lamps, where a small transformer is apt to be burnt up as well as the lamp should a carbon fall out or cross, or a screw work loose, as protecting such lamps with fuses is a matter of extreme difficulty, on account of the limited short-circuit current, and the unavoidable flares and rush of current on starting *new* carbons. The Americans appear to favour long series of enclosed A.C. arcs, but the use of series enclosed arcs, except in special circumstances, is unnecessary and inefficient, and the blueness of the light is a drawback to the system compared with the white light obtained with open arcs using solid carbons. Still, Messrs. Gilbert claim to make an enclosed arc, using two solid carbons, and taking 120 volts across an arc of normal length, which would naturally greatly improve the whiteness of the light and the efficiency.

The lamps used have shunt coils only. The firm first tried the use of series-coil lamps, with reactance coils or chokers across the lamps, but it was found to be greatly inferior and less efficient, whilst the power factor of the circuits was not nearly as good, and the amount of interference of one lamp on the others was undesirable.

In putting down new circuits, it is simpler to wire a number of lamps in series, and one transformer only is required instead of one per lamp, with a gain, of course, in price, efficiency and labour.

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The current in the circuit is, of course, entirely determined by the transformer, and may be varied at will from 10 to 20 amperes, the lamps maintaining their proper voltage at the same time.

The constant current transformers are designed entirely on the lines of ordinary transformers as regards efficiency, induction, &c., whilst the mechanical arrangements are extremely simple, as can be seen from the figure; there are no dash pots, levers, weights, &c., of any kind.

The primary coils are fixed, and the secondary coils are arranged to move away from them. The latter are carried in a metal frame provided with frictionless wheels, which run along a pair of rails carried on either side of the framework. One end of the transformer is arranged to tilt slightly so that the coils tend to run together. The tilt is readily adjustable by screws, so that the current at which the circuit works is easily fixed. A slight variation in the curve of the rails provides for inequalities of moving force, and the current is maintained constant to within half an ampere. Further, the coils are arranged to superpose so that the leakage is reduced to 10 per cent. at their best position, hence a very high power factor can be arrived at.

Great care has to be taken with the metal parts of the frames to avoid enclosing leakage lines in any position.

The transformer has no tendency to hunt. Simple spring buffers at each end of the rails prevent the moving part from shock consequent on switching on and off.

The automatic arrangements are much simpler than those used in continuous current circuits, and if they go wrong the circuit is not extinguished.

The lamps in a circuit like this burn with an equal steady light. Hard cheap carbons can be used, giving a white light; in fact, two solid carbons can be used, taking over 50 volts across a normal ½-in. arc. Messrs. Gilbert always use such carbons (even in single parallel) that the volts across the alternating arc of normal length are about 40, which means a great gain in efficiency and whiteness over the ordinary 27 to 30-volt A.C. arc.

It would seem that with the greater attention which the Gilbert Arc Lamp Company are giving to carbons and efficiency, alternate current lighting, whether in separate parallel or in series circuits, is now much on a par with continuous current lighting.

An interesting feature in the rectified lamps that this company supplied some years ago to Blackpool is that there also the lamps are arranged so that the current can be lowered at midnight if desired. Messrs. Gilbert & Co. find that, particularly with A.C. arc lamps, the current density at which the carbons are run makes a very great difference to the colour and efficiency of the light obtained, and an advantage of their lamps with 6 ft. of carbon is that reasonable hours of burning are possible with a carbon of small diameter.

THE PROPOSED HIGH-SPEED ELECTRICAL "MONORAIL" BETWEEN LIVERPOOL AND MANCHESTER.*

By F. B. BEHR.

Whilst anxious to give you some new and interesting details on the Manchester and Liverpool Electric Express Railway, I approach the subject with great diffidence. There has been so much written and said in connection with this project, that I am afraid you are all familiar with its principal features.

The principle of the monorail which it is proposed to use in the construction of this railway is not a new one.

I myself lay no claim to the propounding of the original idea. All I claim is to have developed the general ideas and principles of others in designing the practical details, and to have constructed for the first time monorails which have been worked successfully for the carrying of passengers and goods on a commercial scale during a number of years.

The special form of the monorail I have adopted was originally thought of by Mr. Charles Lartigue, a French engineer, who so far applied the idea practically as to construct some primitive and simple lines in Algeria and Tunis in 1883 and 1884 for carrying esparto grass and similar produce, the tractive power being animal in all cases.

As electric traction became more perfected from year to year, I was impressed about the end of 1892 with the fact that an even more important application of this principle was to be found in the construction of high speed railways, to overcome the great and increasing difficulties of managing the various kinds of traffic on the existing railways by removing the express passenger traffic on to new rails.

The absolute impossibility to derail on this system, if properly designed, when going at very high speeds through comparatively sharp curves is its principal recommendation for high speed, as it results in absolute safety and economy in construction. The cost of the monorail for average speeds of at least 100 miles an hour would be about the same, or slightly less than the cost of an ordinary two-rail railway constructed for maximum speeds of 60 miles an hour. There is no doubt that ordinary railways could be constructed to work at speeds of 100 miles an hour, if worked electrically, but the additional expense beyond that which is at present necessary would be very great indeed for many reasons, of which the two principal are: the necessity of consolidating the relative position of the two rails in such a way that they would practically form only one, and the impossibility of using curves of a smaller radius than about 3,000 yards, which practically amounts to a straight line, and even with all these precautions the safety obtained could never become so absolute on such lines as it would be on the monorail. For instance, one of the principal causes of derailment on an ordinary railway is bad ballasting or packing of sleepers, which results often from heavy rain, floods, or even neglect. The sinking of two consecutive sleepers ever so little in opposite directions must derail the engine on an ordinary line. On the monorail such an accident would produce no appreciable effect on the position of the driving wheels and of the carriage as the surface of the top rail affected thereby is only 2 in. wide, and would therefore produce such a small twist that it would practically not be observable.

There are many causes which contribute to this absolute safety which can only be understood by carefully examining the detailed construction of the carriage as it fits to the permanent way, when it will be observed amongst other reasons that whereas an ordinary railway carriage is held on the rails by a flange of about ⅝ths of an inch in depth, the arrangement of this carriage really is equivalent to a continuous flange of over 3 ft. in depth, and a feature of great importance to the passenger is that it is not only a very safe way of travelling, but it looks also very safe, and produces on the mind of the traveller a feeling of absolute security.

I finally decided to build an experimental line in the neighbourhood of Brussels as an annexe to the Exhibition of 1897, principally for two reasons:—(1) Because the Belgian Government held out great inducements of large financial help. (2) Because I thought that the Exhibition would enable a large number of people to visit the line. The chief inducement held out by the Government was the promise of finding the necessary motive power to any extent I might require. I asked for 2,000 H.P., which I considered would be amply sufficient. Though the Government agreed to this, the difficulty of finding such power at the Exhibition made them finally cut it down to 1,000 H.P., and I thought I had better accept this than give up the experiment altogether. No current was furnished to me until the middle of June, 1897, when I got a very small portion of the current promised. The electrical station itself was only completed, as far as it ever was, by the middle of July. Practically, therefore, during the Exhibition I was deprived of all the advantages which were promised to me. When the current was finally furnished, some weeks' running were necessary before a high speed could be attained. The electrical station was so badly arranged, the machines being all of different types, that instead of having regularly available 1,000 H.P., I could never rely upon getting more than about 500 H.P. Notwithstanding all these drawbacks the experiments were conclusive in establishing the possibility of constructing at a moderate cost lines on the monorail principle, to be worked at a speed of double that of existing passenger express trains with absolute safety.

The structure itself consisted of a single rail elevated about 4 ft. from the ground, and supported on A-shaped steel trestles. The legs of these trestles were rivetted to steel sleepers resting simply on the ballast. These triangular supports were placed about 3 ft. 3 in. apart, and at each side were fixed laterally two rails, one about 18 in. above the other. These are the so-called guide rails, their object being—

1. To brace the whole system together and increase its stability.
2. To engage the horizontal guide wheels of the car and prevent oscillation.
3. To counteract the effect of centrifugal force when rounding the curves.

The electrical conductor was a steel rail fixed on porcelain insulators attached to the sleepers. These rails were joined together by copper strips to preserve the electrical continuity. The return circuit for the electrical current was made through the line itself.

The car was over 60 ft. long and 10 ft. 10 in. wide.

It consisted of two bogies flexibly coupled together by a specially designed joint.

The part of the carriage below the main rail contained the whole of the mechanism, viz., four electrical motors of about 200 H.P. each, suspended from the girders, and connected to the axles of the driving wheels by specially designed chains.

A rigid iron arm was fixed between the body of the motors and the axles, to which they were coupled. This arrangement made the propelling force absolutely self-contained, so that it could not be affected by any shocks or oscillation that the car might receive.

There were 32 horizontal guide wheels acting on the guide rails for the purposes above described. The whole weight of the car was supported by eight double-flanged main wheels, 4½ ft. in diameter, the centre wheels being driven, the two outer wheels being leading and trailing respectively. The ends of the car were pointed, to diminish the air resistance. The triangular spaces enclosed in these ends were reserved for the driver and conductor. The driver, or electrician, had under his hand the devices for starting, regulating speed and stopping.

As at a very high rate of speed the ordinary friction brakes might not be efficient, a device was invented by me to utilise the resistance of the air at very high speeds as a brake for slackening the speed so as to bring it within the range of efficiency of an ordinary friction brake.

This arrangement consisted of applying at the front end, outside, vertical louvre plates turning on spindles. These presented a large resistance to the air when opened, which increased with the speed of the train, and they could be manipulated at will by the driver.

* Abstract of paper read before the Society of Arts, on Wednesday, March 13th, 1901.

The interior of the car had sitting accommodation for 100 passengers. Each person had a separate seat, specially arranged so as to avoid discomfort while passing round the sharp curves at high speed.

The electrical current was picked up by trolleys attached to the car, but insulated from the bottom of the bogies.

Owing to the imperfect condition of the generating station, the great weight of the carriage and the difficulties of the line itself, the maximum speed obtained during August, September and October (the only months when the car was running during the Exhibition) did not exceed 70 miles in the curves. Still, this result was not unsatisfactory, as to run with absolute safety through curves of 540 yards radius at a speed of 70 miles an hour for three months has never been done before, and this speed could be without difficulty largely increased, certainly to over 100 miles per hour, by increasing the power, or diminishing the weight, or having more favourable gradients. It was only in the beginning of February, 1898, that I was authorised to reconstruct the electrical station, and this was immediately begun, and the whole of the machinery put into working order, while the machine gallery was re-erected. During that time I also came to the conclusion that by removing the top of my carriage and lightening it, more advantageous results might be obtained, notwithstanding the defective electrical station and the difficulties of the line. For that purpose I had a new top to my carriage constructed in Belgium, so that, when completed, the old car with the new top weighed only about 59 tons, instead of 70. This was only completed by the beginning of April, 1898, and from that time till June 11th the Belgian Government Commission, as well as the Commissions of the Russian and French Governments, paid many visits to the line, and carried out many experiments jointly with myself. Every possible measurement was taken, the car was run with half the guide wheels off at the maximum speed, and the car itself was even divided into two parts and one half run at a time.

The tests applied were of every possible character, and the result was the line was found satisfactory in every respect, and capable of withstanding any pressure required, and showing the greatest stability. A speed was recorded at the rate of 83 miles an hour on the curves of 540 yards radius, a result considerably greater than had been attained previously, and probably higher speeds were occasionally attained. Travelling at that speed was extremely pleasant, and there was a feeling of perfect safety. The absence of vibration was marked, and no accident of the slightest kind happened during the whole of the experiments, notwithstanding the many thousands of people who came to see the line. The main results of the trial were that, given a proper line of sufficient extent to acquire the proper speed, and a properly constructed electrical station, very high speeds up to 120 to 130 miles an hour can be attained with absolute safety and moderate expense, so that Lightning Express railways can be built of the form which I designed to run at a speed exceeding considerably 100 miles an hour over the same curves and gradients in use on all ordinary main lines in England with absolute safety, as it is impossible to derail or to interfere with the stability of the line.

As the conditions of the proposed line between Manchester and Liverpool will practically do away with all the difficulties and drawbacks of the Brussels experimental line, it will be easy to attain the proposed speed of 110 miles an hour at a moderate cost on that line. The gradients will be easy and suitable for high speeds, the curves will not exceed 750 yards radius, the electrical station will be constructed with the very best and modern machinery, and with ample power.

Starting from the station in Deansgate, in Manchester, in the very busiest part of the town, it terminates, after a run of 34 miles, behind the Cathedral in Liverpool, situated also in the most central part of that town.

The train will consist of one carriage, containing either 60 or 90 passengers. The trains will start every 19 minutes from either end, and will perform the journey in 20 minutes. The electrical station will be situated exactly half way at Warrington, and will have a capacity of about 7,500 H.P.

The full speed of 110 miles will be attained within 1¾ miles from the start by an acceleration of 1·5 ft. per second.

The carrying capacity of the rolling stock, if only the smaller carriage is used, will be 12,000 passengers per day, viz., 6,000 in each direction, and with the larger carriage this can be increased to 18,000 per day.

If each train carries an average number of 12 passengers only at Parliamentary fares of 1d. per mile, this would cover the whole of the expenses, so that every passenger carried beyond that number will be profit. In another way, if the company carries an average of 5,000 passengers per day in each direction at 1d. per mile, this would be sufficient to pay 10 per cent. on the entire capital of the company, amounting to £2,800,000, and 3,500 passengers at the same rate would pay over 5 per cent. on the same capital.

I should also like to mention here a few words with regard to the absolute safety from collisions on the line, or of accidents of any kind such as one can foresee, and on the proposed system of signals and brakes to ensure that safety.

The question of brakes and signals are so intimately connected that the one cannot be treated separately from the other.

Experiments by many eminent engineers have shown that with the Westinghouse brake it is possible to apply a retarding force of 3 miles per second. That is to say, that the speed of a train travelling 60 miles per hour can be reduced each second by 3 miles, and, therefore, it can be brought to a stop in 20 seconds. During this period the train will traverse a distance of about 300 yards. A train travelling at 30 miles per hour can be stopped in 10 seconds, during which time it will have traversed a distance of 73 yards. These actual experiences, therefore, show that, with the Westinghouse brake alone, it probably will be possible to stop a train travelling 110 miles per hour in 37 seconds, during which time it will have travelled 995 yards.

It is proposed to equip the new railway not only with the Westinghouse brake but also with an electric brake. This consists of one or two small dynamos which are connected for that purpose with the driving wheels. Whereas in ordinary running the current from the generating station is used to rotate the motors, and thus produce speed, by connecting the driving wheels with the dynamos after the current from the generating station is cut off, the rotation of these wheels is utilised to drive the dynamos and manufacture electricity, which is absorbed by resistances provided for that purpose. This effect can also be produced by short circuiting or reversing the motors, converting them thereby into dynamos.

Let me here remark that this does not in the least resemble reversing the engines on an ordinary steam locomotive. There is no question of stopping the driving-wheels so as to make them slide or skid along the rails, but their rotation is used to produce electrical energy, and by absorbing this energy in the wheels creating a strong magnetic field, retard the train.

The power required to stop the train in 500 yards is about 8¼ H.P., or 197 lbs. per square inch on the area of the brake disc.

The main advantage of this electric brake is that it is most effective at the very highest speeds, as of course, a high speed is more effective for generating electrical energy than a slow speed.

With the utilisation, therefore, of both the electric brake and the Westinghouse, it is a matter of mathematical certainty that it will be perfectly possible to exercise a retarding force amply sufficient to bring the train to a standstill, from a speed of 110 miles per hour in a distance of about 500 yards, instead of 995 yards as above stated.

I do not wish to suggest that this is a rate of retardation I should desire to use except in dire emergency (which, however, I will show hereafter to be almost impossible to arise), as though it might not injure the passengers it would certainly be uncomfortable.

I only say that by the brakes proposed to be supplied it would certainly be possible upon an emergency (however improbable) to stop the train within the space mentioned.

It is, of course, evident that the most perfect condition under which a railway could be worked, would be that in which both brakes and signals could be dispensed with; therefore it follows that the fewer the occasions for using either the better.

Now, in the ordinary way of working our existing railways there are many occasions in which it might be important to stop the train as rapidly as possible; for instance, if a train should be seen in front, or some shunting operations were not completed, or other causes too many to enumerate. But no brake, however powerful, is of the slightest use to-day to avoid a sudden obstacle, such as a *stone* placed on the rail, or a *broken* rail, as it is impossible for the driver to be aware of such obstacles until he is very close to them, or practically upon them. For these cases, therefore, the stoppage at 300 yards, or 200 yards, or even 100 yards, is quite useless.

What I wish to show now is, that on the proposed high-speed electrical railway, though it is quite possible to brake the train within 500 yards, it never can be necessary to bring it to a standstill in such a short distance.

On the proposed railway there are no level crossings, no switches, no shunting operations, and, in fact, nothing that will require the train to be brought to a standstill, except in the event of one train preceding another breaking down. Therefore, by clearly explaining the method of signalling the position of each train in relation to the other, the necessity for applying the brakes and the distance in which the trains would have to be stopped in case of a breakdown would be clearly appreciated. Beyond this the brakes need only be used for stopping as you approach the stations.

I now, therefore, have only to explain the manner in which it is arranged that the driver of each train shall be informed of the possible stoppage of the train in front of him.

We will take the case of the line from Manchester to Liverpool, of a length of 34½ miles. As the distance will be traversed in 20 minutes, and a train is to start every 10 minutes in the ordinary way, when everything goes all right, the second train will only leave the station at Manchester when the first has reached Warrington, a distance of 17¼ miles.

We will sub-divide the line for the purpose of signalling, say, into five sections of about seven miles each. As trains leave Manchester station a danger signal is put up electrically at that station. A second similar danger signal is put up as the train passes point 7 miles, the first remains at danger, and the train travels on; when it reaches 14 miles it puts up a third danger signal, and simultaneously the block is removed at Manchester station, so that the second train can leave when the time comes.

Now we all assume that the first train has met with an accident after passing point 14 miles, the second train would travel at full speed, but when it passes point 7 miles, the danger signal at that point not having been removed by the first train, as this never reached point 21 miles, the driver of the second train would be informed that the first train had met with an accident beyond point 14 miles, and, therefore, that he had to slow down, but that for such lowering of his speed he had a clear run of over 7 miles.

Therefore there could be no difficulty in any case to stop even without using the brakes by simply cutting off the current.

Whenever the train passes over a point where the danger signal is put up, this danger signal is also reproduced by a very simple and inexpensive contrivance in the cabin of the electrician, so that the conductor may hear it and see it, even if there was a thick fog.

Under these conditions of travelling it seems superfluous to have any emergency brakes, and though we shall be able to stop the

trains within 500 yards, in no case can be imagined in which it would be useful or necessary to recort to such stoppage.

A six minutes' service of trains can be established by reducing the sections to four miles, and if a three minutes' service was required, the block would have to be reduced to two-mile sections, giving a clear run of two miles in case of a breakdown.

Of course it is useful to have a powerful Westinghouse brake to stop as rapidly as possible at the station. This can be done easily in 1,000 yards on the level without using the electrical brake at all, and as we have a rise of 24 ft. in the last 1,500 yards going into Liverpool and a rise of 46 ft. in the last 1,200 yards going into Manchester, the cutting off of the current and the application of an ordinary Westinghouse brake about 1,200 yards from the station, will stop the train quietly and comfortably at the stations.

In choosing for the first line to be worked at these speeds, the line between Manchester and Liverpool, the same reasons hold good which made Stephenson choose it for the first application of the steam railway. I hope to prove thereby to the great railway companies the advantages they would derive in adopting on all great main lines this system for the express passenger traffic alone, thereby solving the problem of increased speed with absolute punctuality, and punctuality not only for the express trains, but also for the working of their enormous traffic on their present rails, consisting of an ever-increasing local passenger and goods traffic, which often so blocks the existing railways as to render their safe and punctual working absolutely impossible.

CORRESPONDENCE.

Electrical Trades Union.

May I take the liberty, through your valuable paper, to thank Mr. A. Rogers for his kind statements? Your readers would think better of him if he would get a few facts before making public statements. The following will show that he made them with no knowledge whatever. I consider that my statements in my letter are fully admitted by Mr. Rogers' statements in his letter, and it may be interesting for Mr. Rogers to know that the two men in question are prepared to verify my statement. He further goes on to say he visited my house, Broadway, Salford, Manchester, to find I had removed. This is wrong. My people removed before Christmas. My address is to this day, Broadway, Salford, and I think Mr. Rogers is giving a rather tall order in disputing any one's address, it having little to do with the business. He further states that I live at Hulme. I believe my people have removed to City Road, Manchester, but have not yet been there myself, as I have only just returned from Cape Town. But I defy him to give my address as Hulme. He speaks about the United Kingdom, but how much of it out of Lancashire does he mean. I have had 10 years' experience, all in the electrical trade (not half at painting or something else) in Europe, Australia and Cape Colony. He states I joined the wiring trade in May, 1894. Now, in the *Aberdeen Free Press* of February 13th, 1894, he will find an account of the Carnival held there, in which it is stated that the entire electrical installation is under the direction of Mr. J. J. Wood. It consisted of an arc installation of 50 15-ampere lamps and 300 incandescent lights. In mentioning this, I leave it for the reader to judge whether Mr. Rogers was justified in stating that he showed me how to fix my first ceiling rose. This is prior to knowing Mr. Rogers, or Mr. Rogers knowing me.

Previous to going to Aberdeen I had two years at engine fitting under the training of my father, at the Simplex Electric Light and Plant Company, Eccles, of which my father was works manager. After leaving Eccles I still remained with my father at Howat's, Chester Road, on engine fitting for colliery machinery. Now, being very smart at handling my tools and desiring the electrical branch, I got a position as open type switch fitter at the G.E.C., remaining there six months, going to a better position in the telegraph instrument department at Cornbrook Telegraph Works, Hulme, remaining there seven months. I then went to Aberdeen. Leaving Aberdeen I met Mr. Rogers, who speaks from then of knowing me, for 18 months in all. To save valuable space, I may mention I have contracted and carried out entire installations for 13 theatres and music halls in England, two in Australia, (Melbourne and Sydney), and one in Cape Town, from where I have just returned. I will give the full names and addresses of theatres and managers to Mr. Rogers, but I don't take the liberty on myself to publicly print them. But it may please Mr. Rogers to know that this novice stands third among English firms for theatre contracts. My work includes both gas and steam engine plants and town supplies, and I stand to-day a theatrical electrician of repute, and if Mr. Rogers has had any experience in the wiring of some of the gorgeous scenes put on in some of our English pantomimes of to-day, he will admit that the wiring of same requires greater care and skill than ordinary shop or warehouse work. So I think I have made it clear that Mr. Rogers made a bold and groundless sweep on my reputation. I close, with still my sympathy with "Jointer."

J. Johnson Wood.

Broadway, Salford.

N.B.—If he will try a little lower down Broadway, he will find out where his mistake is.

[This correspondence must now be considered closed.—Eds. Elec. Rev.]

Applicants' Out-of-Pocket Expenses.

Some little time ago an advertisement appeared in your estimable journal, inviting electrical engineers to apply for an appointment in China. It appears that a fairly large number were willing, out of consideration for the emoluments of the office, to exile themselves from their native land, and run a possible risk, later on, of being mistaken for a Missionary, and losing their heads by "Boxers." But, of course, as is usual, only a very select few—only 22, in this case, some of whom had to travel 200 miles—were asked to attend in London to be interviewed, myself among the number.

No decision was arrived at that day, but later on I was advised, in common with the other 20 unsuccessful applicants, that I had not been appointed. I naturally sent in my railway expenses, as is always done—excepting in a recent appointment where I was one of the selected in a Scotch town, first class expenses being paid to each one of the applicants, who had been invited to attend the Council meeting, before the interview took place, a practice, by the way, which commends itself very strongly to all Corporations as well as the applicants—but received a letter to say that as no mention had been made about expenses, and that as I had received the honour of an invitation to appear before their representative, somewhat after the fashion of the proverbial donkey and the carrots, I ought to consider myself satisfied with the empty honour, while the successful candidate not only receives the plum of appointment, but strange to say, is also paid his travelling expenses, leaving the remaining 21 unsuccessful candidates to pay their expenses out of their own pockets.

Naturally, Mr. Editor, as the procedure neither accords with a sense of common equity nor with established precedent, a great many unkind things are being said, and in some instances actions are pending for the recovery of these travelling expenses, and with a view of reducing the cost and bringing the recovery of these expenses into a common action, I shall be glad if the other 20 unsuccessful candidates will send in their names and addresses to your good self in the first instance, when we can jointly press for recovery.

It appears from a letter I have seen, which was written to one of the solicitors to one of the parties referred to, that this municipality refuse payment, because in the majority of instances they have not been asked to pay them, and that it is not customary to do so.

Perhaps, Mr. Editor, you will be good enough to enlighten their darkness on the latter assumption, which is no doubt due to their long association with the "Heathen Chinee."

Boxer.

Depreciation.

I am sorry to have to again trespass upon your valuable space on the above subject, but, referring to your kindly criticisms on my letter in your leading article—which criticisms remind me very much of the procedure adopted by counsel when endeavouring to force out of a witness something he never intends to say, to misinterpret and turn about

his evidence in such a manner as to appear to make your own "no" case good. You say, "We presume that he does not consider it necessary to provide for the renewal or reduced value of his plant at all." My letter says that "I consider 2·83 per cent. on the total capital sufficient to pay for the entire renewals of the plant, provided it be kept in *perfect* repair from year to year, which repairs are, of course, charged to the *current revenue* account."

You do not appreciate the fact that by the sinking fund, in 25 years, the whole of the capital expended will be repaid, so that the power house, boilers, engines, cables, and all the plant, will be the property of the local authority, and that their position will then be they can borrow afresh for new plant, having extinguished their previous loan, and will also in addition have as assets the remaining value of the old plant, and I do not think you would be prepared to say that the then value of the plant would be *nothing*. Now take the case of a company where they *never* extinguish their loans, but go on *increasing* their capital, and putting aside a certain sum annually (or if they do not they should) to allow for depreciation and renewals, as against the Corporation that is continually paying off and reducing its capital as it goes along. It is evident that the position of the two would be the same provided they both set aside the same amount, and it matters very little whether it be called sinking fund, depreciation, or renewal fund, as the ultimate financial effect is the same, with the exception that by extinguishing the loan no interest has to be paid on that portion, but in the case of a company which increases its capital, interest has to be paid on the total amount issued, which is rarely redeemed. Glasgow appears in your mind to be a "model" of what should be done; but it is well to remember that this year they thought it advisable to adopt 4 per cent. to make up for the number of years previously when they did not provide sufficient depreciation. Their position financially is no better than that of those Corporations who, from the very commencement, have been quietly putting aside an amount which will redeem the whole of their capital in 25 years.

In your first article on depreciation you drew comparisons between company and local authority working with respect to the amount set aside, but you take exception to my quoting the practice of companies, and from your remarks last week I take it that you are of the opinion that not *only* are the local authorities in an unsound financial position, but that the companies who are setting aside *smaller* sums than the local authorities are in a much worse position.

Your conclusions from Sir David Salomons' advice are incorrect; the idea of forming a reserve fund was not so much to pay for the renewals as to meet any unforseen contingency. It is well understood that all renewals that have to be made to mains, machinery, or boilers, &c., must be paid for as *repairs*, and charged to the revenue account for that year in which they are undertaken, and it was Sir David's and my opinion that we should form a reserve fund, so that a serious mishap should not adversely affect our profits for that year.

"The statement of profit was fallacious." These were the remarks made by a worthy alderman, an important gas director of the "local company," which company does not set aside (according to its balance-sheets) *as much* as the electricity undertaking does. Furthermore, we have, on the advice of the town clerk, carried forward every year a sum of about £2,000, instead of transferring it to a "reserve fund," as his opinion was, that it would be much more easily dealt with as a "balance carried forward," than it would if it were put to a reserve fund, so that if you like to consider it as such, our position is as follows:—

We have now been in operation five years. Our capital outlay is £42,000. We have put aside for redemption of our loan £3,319, we have in hand a balance of £2,039 carried forward, making a total amount to meet depreciation, renewals, &c., of £5,358, and I do not think you will find a company or corporation in a more healthy condition in proportion to its capital. It must not be forgotten that five years ago the whole of our machinery was new, whereas, in the case of Glasgow, a large proportion of it was old, and had done a good many years' service, and may I ask you to set out the same interesting table with respect to Glasgow, working it out on the 2·83 per cent. basis *since* the start and compare the total that the Glasgow Corporation have carried to depreciation and reserve?

With regard to your paragraph of the figures showing the depreciation year by year, and the actual amount paid back, you must not forget that capital has to be spent before the machinery is *actually* in use, whereas the machinery cannot very easily begin to depreciate before doing work, and therefore the £439 allowed in your column is not necessary, as the works had only been running a few months.

I take strong exception to you endeavouring to put upon me the onus of casting a reflection upon companies' electrical engineers. I never intended, nor can I understand you interpreting from my letter, any such impression, as I certainly thought you were aware that it was the directors that had to sanction the expenditure of money for the purpose of undertaking repairs. However, that does not remove my statement that there is a stronger inducement to economise the expenditure in repairs (by the directors of the company) than there is by a municipal committee (whose money is not their own)—at least, this is my view of human nature. It will be interesting to know what you consider was the Local Government Board's idea in requiring corporations to adopt a sinking fund, as apparently you do not consider a sinking fund necessary in the case of a company, although they are both working on the same lines, except that the corporation has the order for perpetuity.

In conclusion, may I ask the following questions:—

1. What do you consider the sinking fund provided by a municipal authority is meant to cover?

2. As you do not consider the sinking fund should form part of the depreciation fund, why don't you think companies should form a sinking fund as well?

3. Do you consider any corporation or company setting aside less than 4 per cent. per annum to cover depreciation, in an unsound condition?

Horace Boot,
Borough Electrical Engineer.

Tunbridge Wells.

Local Authorities and Supply Companies.

Is there any need for feeling to run so high between local authorities and companies? Surely the time has arrived when each must recognise that the other has its own proper and useful sphere. Personally, we have to admit from our own experience in acting for both sides that much might be gained if they would try and understand one another a little better, and that where this is done the happiest results always follow; neither side has anything to gain from blind opposition. Before much headway can be gained, however, the more zealous representatives of both must moderate their tone. Companies must recognise that the Board of Trade is right in allowing local authorities to judge what is best for themselves within their own boundaries, but possibly the position might be made more equitable if the Board could see its way to require the authorities to give evidence of the sincerity of their undertakings, by passing formal resolutions to proceed with the works. This would be no hardship, as most authorities do act in all sincerity, but their reputation has been damaged by certain others who have schemes prepared, apply for orders, and through their agents state that they really intend to go forward, whilst their successors in office, once the danger has been averted, calmly drop the whole subject. This is a very undesirable state of affairs; does a genuine injustice both to authorities who are acting in a *bonâ fide* manner and to companies alike, and retards progress. We therefore venture to hope that the Board of Trade who, as everybody must admit, are striving only to do what is right, may see their way to test the abilities of any parties coming before them to carry out the pledges they give. This, of course, applies equally to promises made before a committee of the House.

Handcock & Dykes.

The Briton and his Commercial Rivals.

The bogey of "Made in Germany," and the reiterated cry that British commerce is being worsted in every market of the world, lead me to ask for a little space in your columns to place before your readers one or two reasons

why they need not give way to feelings of despair or even despondency over the situation. By the articles which are published from day to day in newspapers and magazines, our foreign trade is made to appear decadent, while that of Germany and America is shown to be as rapidly growing. "Give a dog a bad name and hang him"; tell the whole world day by day that the Briton is a degenerate, and that his German and American rivals are cutting him out, and the prophets will bring about the fulfilment of their own forebodings; merchants and manufacturers will become discouraged, and capitalists will look abroad for more promising fields in which to invest, and then we may write "Ichabod" over the gateways of our custom houses. A great number of writers take it for granted that Germans and Americans have made relatively far greater progress than Britons during the past 20 years; indeed, the opinion of some of the authorities in the symposium on this subject, held in a monthly review this month, clearly is, that Britain has lost its supremacy in the field of foreign commerce, and that it has fallen into a second or third place, behind Germany or America. I have seen enough of German and American factories and institutions to fill me with respect for them, yet I have felt no uneasiness concerning our own prospects. It may be all very well to attempt to spur on the British manufacturer to greater endeavour by warning him of what his rivals are doing, but exaggeration, and, in many cases, false statements, are not justifiable.

With your permission, Sir, I would like to lay the following broad statement of facts before your readers, so that they may draw their own conclusions, from official data:—

The annual gross exports of merchandise from the United Kingdom, Germany, and the United States of America, as given in the Statistical Abstract of the Board of Trade, divided among the inhabitants of the respective countries, during the period from 1879 to 1899, split up into three equal terms of seven years.

Periods.	United Kingdom, total exports *per capita*.	Germany, total exports *per capita*.	U.S.A., total exports *per capita*.	Germany and U.S.A., combined total exports *per capita*.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1879 to 1885	8 4 1	4 17 5	3 2 2	7 19 7
1886 to 1892	8 0 11	4 8 4	2 14 1	7 2 5
1893 to 1899	7 9 0	3 12 2	2 18 9	6 10 11

The above decreases are due to the fall in value of late years, the actual volume of trade has, of course, greatly increased.

Besides showing that the Briton is doing more, man for man, than his two great rivals combined, the above statement proves that he is increasing his lead. In the foregoing the export business only has been taken into account, and, moreover, no credit has been claimed for the great preponderance of the British shipping and financial interests, in which this kingdom is *facile princeps*.

Thanking you in anticipation for the space granted me in your influential columns.

Geo. J. S. Broomhall.

Royal Statistical Society's Rooms,
9, Adelphi Terrace, Strand, W.C.,
March 25th, 1901.

[We refer to this letter in our "Notes" columns.—Eds. Elec. Rev.]

A Charge Engineer's Complaint.

A few weeks ago a notice appeared in the technical papers advertising a vacancy for a charge engineer at the central station of the Plymouth Corporation, and although applicants were allowed until March 12th, I sent mine in at once.

Several days after I was considerably surprised to receive a reply signed by the borough electrical engineer, informing me that my application had been unsuccessful, another person having been appointed, and this, although the advertisement again appeared, and distinctly said that applicants were allowed until March 12th.

This is apparently a case where the whole matter had been settled before the advertisement appeared at all, and if such is the case, it does not reflect much credit on the methods of the Plymouth Corporation.

I am afraid there are many such cases as mine in England, and I think it is a gross injustice that men should have to spend their time and money in applying for appointments where they will not have the slightest chance of success unless they are already in favour with the powers that be.

A good deal has been said of late about War Office reforms, but the community at large might derive more benefit if legislators would give some attention to reforming the methods of our local governing bodies.

It would be interesting to hear from others who have been served as I have been.

An Unsuccessful Candidate.

I am obliged by your favour of the 21st inst., enclosing me copy of proof of a letter which has been sent to you for publication.

I am very sorry that the candidate in question should feel aggrieved because his application was not successful.

Although applications were received up to the 12th inst., yet I opened them as they came in, replying at once on the form enclosed to all those applicants whom I did not think suitable for the post, putting on one side those who were suitable, for further consideration when all the applications were received.

The writer of the letter assumes that the whole matter was settled before the advertisement appeared at all, but it may interest him to know that it was not until Monday last, the 18th inst., that anyone was selected for the post.

The final selection was made on that day, without any reference to me, by my successor, Mr. E. G. Okell, after a personal interview with two candidates, and the gentleman selected was a perfect stranger to him.

The wording on the printed form, which you will see is some years old, has apparently misled your correspondent, and caused him to impute motives, under an anonymous shield, to public officials.

John H. Rider.

Plymouth, *March 23rd*, 1901.

The Synchronising of Alternators.

Your correspondent in the Electrical Review for March 22nd again brings into prominence the difficulties of synchronising. Some years ago that question was much discussed, and with justification, since the poor design of both alternators and engines did in many cases create serious difficulties.

For a long time nothing more has been heard, a sure sign of a sufficient improvement.

If your correspondent still finds serious difficulty in paralleling his machines, he must have been unlucky in his choice of plant.

Engines can easily be had which have a sufficiently even turning movement for all cases now occurring in practice.

The limits of irregularity in this respect I have pointed out in a recent article published in the Review.

There are also alternators on the market which would satisfy the most difficult to please, as far as parallel running is concerned, and which are able to stand any amount of knocking about.

I have designed a number of alternators for various stations in this country and abroad; these alternators run in parallel with machines of almost every make, driven by a variety of engines, and in no case have I heard of any difficulty; the mechanical design is such that I make it a rule when testing these machines to short circuit them through a copper-wire fuse, taking some little time to blow at 2·5 to 3 times the working current. This fuse is placed in parallel with the load and its circuit closed when the alternator is working at its full capacity; after the fuse has been blown the machine immediately continues to work on its load, the circuit of which is never broken. No damage whatever is taken by any part of the alternator by such treatment.

I have known one of these machines burn out a faulty cable and resume its work at normal voltage before the

engineer in charge, who was at the time in the boiler house, could reach the switchboard.

I grant that an awkward difficulty may arise when in a fully-loaded station, one big set gives out, thus heavily overloading the remaining sets; under such conditions the fittest

Fig. 1.

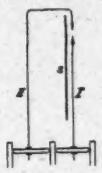



Fig. 2.

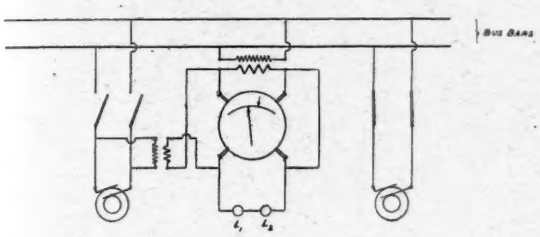


Fig. 3.

only will survive, the others falling out of step, no synchronising gear likely ever to be invented, could be of any help at such a juncture. The remedy is simply *uniformity* in a central station, of size if possible, but more particularly of type.

If all the sets are of the same type, the worst that will happen will be a drop in voltage, but the machines will keep in step.

If uniformity of plant was studied more than it is, our stations would certainly be less interesting to visit, but far easier to run.

I might add a few words about a scheme of connections for synchronising, which, although possessing some marked advantages, is, I believe, little known.

The voltmeter used, figs. 1 and 2, is a double one, and may be of any make; the hot wire type answers best however. Pointer I being the lightest, is preferably used to indicate the phase of the incoming machine, whereas the bent pointer II records the bus bar voltage.

Pointer I is in series with the bus bar transformer and the incoming machine transformer.

Pointer II is in parallel with the bus bar transformer.

It is advisable to use the lamps L_1 L_2 instead of voltmeter 1 until the machines are nearly synchronous, in order to avoid any damage to the instrument due to the rapid vibrations it would be subject to.

When the two pointers come to face each other at the topmost end of the stroke of pointer I, we know that not only do the phases agree, but also the voltages.

There is only one instrument to watch in order to get both phase and voltage correct.

Any alteration of the bus bar voltage is clearly shown, and at once affects pointer I, showing also directly whether the excitation of the incoming machine is to be increased or diminished.

Fig. 3 shows the complete diagram.

Val. A. Fynn.

Bradford, *March 26th*, 1901.

PARLIAMENTARY COMMITTEES.

King's Norton and Northfield Tramways.

The hearing of the King's Norton and Northfield Urban Districts Tramway Bill was commenced before Lord Stanmore's Committee of the House of Lords on Wednesday last week. Mr. Balfour Browne, K.C., Mr. Ram, K.C., and Mr. J. S. Pritchett appeared for the promoters, and the opponents, who are property owners in Middleton Hall Road, along which the tramway was proposed to run, were represented by Mr. Littler, K.C., and Mr. Trevor Lewis.

Mr. Balfour Browne explained that this was practically an ordinary tramway Bill, and was to be worked on the overhead electric trolley system. The main object was to connect the lines which existed in Birmingham with the district, and the principal proposal was to make two great main thoroughfares for traffic, one along the Pershore Road and the other along the Bristol Road from Northfield. The total length of the proposed tramways was 11½ miles, and the cost £130,000. The opponents were property owners, and as frontagers did not want the tramway. He contended, however, that the class of property was not such as would be injured by the tramway.

A number of witnesses were called to prove the practical convenience the proposed tramways would be to the district.

Mr. C. H. Gadsby, engineer, said he approved of the selected route for the tramways. An average of a 15-minute service would be adequate for the district, and he thought they would pay.

Mr. Littler then addressed the Committee for the objectors and said they objected to the whole scheme.

Evidence have been called on behalf of the frontagers, several witnesses expressed the opinion that the scheme would not pay.

On Thursday Mr. Ram made a proposal on behalf of the promoters with the object of meeting the opposition. He suggested that the tramway along Middleton Hall Road should not be constructed without the consent in writing of the majority of the owners, lesses and occupiers of the property abutting the roads comprising the route of the proposed tramway; that tramway wood-blocks should be used for paving the roadway, and that single-deck cars be used along this line.

Mr. Littler rejected the proposal, as he believed the Committee would come to the conclusion that the whole scheme was objectionable.

Further evidence was called in opposition, including that of Mr. J. E. Waller, civil engineer, who expressed the opinion that the scheme would not pay. He thought it would result in a charge on the rates of something like 5¾d.

The Committee decided to pass the preamble of the Bill except so far as related to No. 5 tramway (which traversed Middleton Hall Road). The Chairman called the attention of the promoters to a recent report of the Local Government Board on the subject of borrowing, and said the Committee thought the amount to be borrowed under the scheme should be specified in the Bill, and should be subject to what the central authority required.

This Mr. Ram consented to do.

Bury Corporation Tramways.

The Bury Corporation Tramways Bill was down for consideration before a House of Commons Committee on Thursday last week. No counsel appeared on the petition, and the Bill consequently goes forward as an unopposed measure.

Handsworth District Council Bill.

The Bill of the Handsworth Urban District Council, which has for its object the obtaining of further powers in regard to tramways and electric lighting, was mentioned before Lord Stanmore's Committee of the House of Lords on Wednesday last week. It was explained that the petition of the London and North-Western Railway against the Bill had been withdrawn, and that consequently the Bill would go forward as an unopposed measure.

Sheffield Corporation Bill.

The omnibus Bill of the Sheffield Corporation came before Lord Newton's Committee of the House of Lords on Thursday last week. The chief opponents of the Bill were the Sheffield Gas Company, who feared injurious effects from electrolysis from the Corporation's electric tramways.

Mr. Claude Baggallay, K.C., who appeared with Mr. Balfour Browne, K.C., for the Corporation, said the question raised by the gas company was whether there should be provision made for the protection of the company's gas mains against the possible effect of electrolytic action on pipes and mains. One of the things to be done under the Act was to make provisions for various tramway extensions into certain areas which had been lately taken into the borough, also to authorise the construction of connecting links of tramways and the doubling of certain tramways. Twelve tramway works were proposed, and all except one, which was for the construction of a tramway a mile and a quarter long, were for short junctions or doublings of lines. The gas company asked that a provision should be inserted to prevent injury by electrolytic action, but it was contended by the promoters that the Board of Trade regulations afforded sufficient protection for the petitioners, and it was not desirable that these regulations should be departed from by the introduction of special provisions into local Acts of Parliament.

Mr. A. L. Fell, electrical engineer, and general manager of the Sheffield Corporation Tramways, described the nature of the proposed tramway works, which were not different from the tramways in any other part of the city.

Mr. Freeman, K.C., who appeared for the gas company, said they did not object to the construction of the tramway, but only to the principle.

Mr. Fell said the gas company had never made complaint to the Corporation as to electrolytic action of the tramways, and if the Board of Trade regulations were not complied with, the company could take action against the Corporation.

In cross-examination, Witness said the rails were not insulated in a technical sense, but he admitted that if it could be proved that

the tramways did injury to the pipes, the Corporation ought to make good the damage. He did not think the Board of Trade had power to insist on insulated rails. The only possibility of the pipes being electrolysed was if they were laid imperfectly, and that was not the case in Sheffield.

Mr. H. F. Parshall, engineer, said the arrangements at Sheffield afforded all necessary protection for the pipes.

Mr. R. Hammond, electrical engineer, said he visited every great city on the Continent three times last year, and had never been told anything about electrolytic troubles, which in fact did not exist.

Mr. H. Thomas, the secretary and general manager of the gas company, was called, and stated that the matter of electrolysis was of considerable importance to the company. Last year they had not sufficient knowledge of the effects of electrolysis to oppose the tramway proposals of the Corporation, but the injurious effects of electrolysis had come to their knowledge last autumn.

In cross-examination, Witness admitted that there had been no electrolytic action on the pipes since electricity had been introduced in connection with the tramways in Sheffield in 1899, but the line was not long enough to give the matter a test.

Prof. J. Perry, president of the Institution of Electrical Engineers, was called, and stated that electrolysis was no mere scare. One ampere for one week would remove one cubic inch of iron and two cubic inches of lead, and if the soil was damp or salty the proportion would be greater.

Mr. Wordingham and Prof. Ayrton endorsed the evidence of Prof. Perry.

Mr. Freeman asked that the following clause should be inserted in the Bill:—"Provided that notwithstanding anything contained in the said Acts or this Act if it be proved that any injury or damage to any main pipe or apparatus of the Sheffield Gas Light Company shall have resulted from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction on any of the tramways for the time being belonging to the Corporation, nothing in the said Act shall relieve the Corporation from any liability to make compensation for such injury or damage which would have existed but for the passing of the said Acts and this Act."

Mr. Balfour Browne argued that in America they worked under no regulations, and consequently in that country there might be injury from electrolysis, but in this case the company would get all the protection they required under the Board of Trade regulations. While it was true that such a clause was inserted in the London County Council's Act, yet the system to be adopted in London was very different from that of Sheffield. In London it was proposed to have underground electric traction, but in Sheffield they had the overhead system.

After considering the matter in private, the Chairman announced that the Committee were of opinion that the Bill might proceed, subject to the addition of the clause suggested by the gas company.

LEGAL.

London County Council *v.* Metropolitan Electric Supply Company, Limited.

In the Chancery Division of the High Courts of Justice on Friday last, before Mr. Justice Farwell, a motion in this action came on for hearing. The motion was made on behalf of the defendants, for whom there appeared Mr. Balfour Browne, K.C., and Mr. Sargent, while the London County Council were represented by Mr. Butcher, K.C., and Mr. Methold.

Mr. Balfour Browne, K.C., in opening the motion, said that it was one in pursuance of Sec. 4 of the Arbitration Act of 1889, and its object was to ask the Court to order that all proceedings in the action might be stayed. The section provided that if any party to a submission, or any person claiming thereunder, commenced legal proceedings against any other party to the submission in respect of any matter agreed to be referred to the arbitrator, such party might, before delivering pleadings or entering an appearance, apply to the Court to stay the proceedings; and the Court, if satisfied that there was no sufficient reason why the matter should not be referred to the arbitrator in accordance with the submission, might make an order staying the proceedings. Sec. 24 of the same Act set forth that the Act should apply to every arbitration under any Act passed before or after the commencement of this Act as if the arbitration were pursuant to a submission. The matter now in dispute arose out of the London County Council Improvement Act of 1899, under which the County Council got leave to make a very important thoroughfare from Holborn to the Strand. The Metropolitan Electric Supply Company had one of their great generating stations at Sardinia Street, which was in the line of the proposed new thoroughfare. They opposed the Bill, and said that it was absolutely imperative that they should have a continuity of supply, and that if, by the carrying out of the County Council's operations, they were stopped for a single day in giving that supply to their customers, those customers would go elsewhere, and the company would lose them altogether. To meet that objection, a clause was inserted in the County Council's Bill. The defendant company did not want compensation. What they wanted was to secure continuity of supply to their customers. The Act, as he had said, was passed in 1899, and the section to which he had referred set forth that provision should be made for reinstating the generating station of the company in such a situation as should not constitute a nuisance; that the London County Council should not enter upon the existing site until two years after they had provided, at their own expense, and had vested in the company, a site clear from buildings, and available for the generating station. That was to say, they were to give the electric supply company a site and give them money to erect the new generating station. Then there was the section which provided for arbitration in case of difference, and the company had appointed their arbitrator, while the London County Council had until Monday to appoint theirs. According to the terms, the County Council were to pay the company a sum equal to the cost and expense of erecting and fitting up a new generating station with new plant and with a capacity to generate and supply electrical energy to an output of not less than 4,000 kw. The Council were also to pay to the company for any damages, costs, and expenses incurred, if any failure occurred, in consequence of the works, to maintain their supply. The compensation was to be settled by arbitration under the Lands Clauses Consolidation Act of 1845. Any difference was to be determined by arbitration under the Arbitration Act of 1899. There had been negotiations with regard to the clause about the new plant. He thought the London County Council had misunderstood the Electrical Supply Company's contention, because he found in the writ in the action that they asked that the company should be enjoined from fitting up a new station with plant which would give an output of more than 4,000 kw. He thought that that was a misapprehension. The company had never asked to have plant and machinery capable of an output of more than 4,000 kw. What they did demand was plant and machinery capable of producing and supplying "not less than" 4,000 kw. at any time. That was their whole contention. He submitted that the arbitrator was to determine what plant would secure them in an installation that would enable them to "supply" not less than 4,000 kw. steadily and constantly. If the word "generating" stood alone, plant for 4,000 kw. would do it; but it would not "supply" electrical energy continuously up to 4,000 kw. For instance, there would be at times cleaning, alteration, repairs, and breakdowns, and if the plant were constructed with power to produce only a maximum of 4,000 kw. then in these emergencies the production and supply would fall below that maximum. But the arbitrator was perfectly capable to determine that matter; and besides the onus was upon the County Council to show why it should be settled in this Court. The arbitration was pending, and there was no reason to suppose that it would take long. The present procedure was double the expense. If his Lordship had to hear this matter, he would require expert evidence as to the amount of plant necessary for supplying 4,000 kw., and all that could be taken by the arbitrator.

Mr. Justice Farwell: Then I understand that the point between you is whether 4,000 kw. is the maximum that the plant is to be capable of supplying, or whether to provide 4,000 kw. involves a plant capable of generating 5,000.

Mr. Balfour Browne said that that was so; but that, he submitted, was a matter for the arbitrator, and if there was any dispute, it was always in the power of the arbitrator to state a case for a superior Court if any point of law arose. The arbitrator would find all the facts for the Court, and the Court would decide on the interpretation of the County Council's Act. All that he was now asking was to stay the proceedings pending the arbitration.

Mr. Butcher pointed out that there was no such statement on the papers before them.

Mr. Justice Farwell said he was not quite sure that this motion would not make the matter more expensive to the parties.

Mr. Balfour Browne said that if his Lordship were able to deal with this matter on that day he would not object, because that would clear the ground, and the parties might go to the other Courts for a final decision at once; but any delay would be a very serious thing, as the company were to have possession by August. The whole question was that the plant was to be plant, not merely for generating 4,000 kw., but for supplying 4,000.

Mr. Justice Farwell said it seemed to him that the only question left to the arbitrator was the question of value. What the nature of the thing was, it seemed to him, was not sent to the arbitrator.

Mr. Balfour Browne said that it was an everyday occurrence for an arbitrator to state a special case.

Mr. Justice Farwell said that he should have thought that bodies like the County Council of London and the Electric Supply Company could have agreed about what was the most convenient course in such a matter as this; but he was willing to expedite the hearing of the case and endeavour to take it before Easter.

Mr. Butcher said it was his interest to proceed immediately, because the London County Council wanted to make this street, and they wanted it done at once. They, therefore, wanted to know on what basis they were to proceed. Before Easter would be rather soon, but they could be ready by the week after Easter.

Mr. Justice Farwell said it might be convenient and a saving of expense if he were to hear it.

Mr. Balfour Browne said that a difference of 1,000 kw. might mean a difference of between £50,000 and £60,000. It was really a question of convenience, and if his Lordship thought that the matter should be heard by the Court, his clients would not object, for if his Lordship gave his decision the arbitrator would be bound to consider it as good law, unless the decision were taken to the House of Lords, where it might be sustained or reversed. For himself, however, he should have thought that the more convenient course would have been to stay proceedings. The only question was, What plant was necessary to secure a "supply" of 4,000 kw.?

Mr. Justice Farwell said he did not, as at present advised, think that was within the submission. He would undertake to expedite the hearing of the case for the parties, but he could not do more. This motion would stand over until then.

It was then arranged that the hearing should take place on Wednesday, April 24th, and that the proceedings in the arbitration should stand over until after his Lordship had given his judgment on the matter in dispute.

Manchester and Liverpool Electric Railway Syndicate, Limited *v.* Cavendish.

This case was in the list for hearing before Mr. Justice Channell in the King's Bench Division on Wednesday. Upon the case being called on, counsel stated that it had been settled, and that there would be judgment for the plaintiff on the terms endorsed on the briefs.

Judgment accordingly.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Mar. 27th, 1900.	Value
Alexandria	£36
„ Teleg. mat.	113
Barcelona	55
Boulogne	34
Buenos Ayres	267
„ Teleg. wire	37
Cadiz	270
Calcutta	500
Cape Town	94
Carthagena	48
Channel Islands	100
Christchurch	35
Colombo	611
Copenhagen. Teleg. mat.	47
Demerara	20
Durban	481
„ Teleg. mat.	827
East London	174
„ Teleg. apparatus	166
Gothenburg	50
Hong Kong	480
Malta	55
Melbourne. Teleg. cable	2,328
Nagasaki	144
North Atlantic. Teleg. cable	20,000
Penang. Teleg. mat.	140
Rangoon	30
Rockhampton. Teleg. mat.	80
Saigon	30
Shanghai	178
Singapore	87
„ Teleg. mat.	103
Stockholm. Teleg. mat.	209
Sydney	901
„ Teleg. mat.	40
„ Teleph. apparatus	208
Wellington	567
Yokohama. Teleg. cable	20,419
Zanzibar	96
Total	£49,458

Week ending Mar. 26th, 1901.	Value
Adelaide	£62
„ Teleg. cable	68
Alexandria	87
Amsterdam	60
Bombay	84
Boston	145
Buenos Ayres	206
„ Teleg. cable	130
„ Teleg. mat.	249
„ Creosoted teleg. poles	340
Calcutta	555
„ Teleg. cable	195
Cape Town	1,388
Coatzacoalcos. Teleg. appts.	135
Colombo	104
Copenhagen. Teleg. wire	51
Durban	697
East London	15
Fremantle	36
„ Teleg. mat.	234
„ Teleph. cable	1,172
Grenada. Teleg. Apparatus	41
Hobart	1,851
Hong Kong	1,009
Huelva	680
Madras	135
Malta	10
Melbourne	351
North Atlantic. Teleg. cable	2,600
Ostend	204
Penang	115
Pernambuco. Teleg. cable	15,500
Perth	76
Port Elizabeth	13
Port Said	26
Rio Janeiro	17
Rotterdam. Teleg. mat.	43
Santiago de Chili. Telephones	98
Sydney	1,739
„ Teleg. cable	149
Trinidad	4
Wellington	8
Zanzibar	143
Total	£30,666

Foreign Goods Transhipped.

	Value
Brisbane. Teleph. appar.	£112
Paris. Teleg. cable	52
Total	£164

	Value
Bangkok. Electl. machny.	£310
Total	£310

Boiler-covering.—We understand that Messrs. F. Leroy and Co., of Lower Broughton, are covering the boilers, steam pipes, &c., at the St. Anns' U.D.C.'s new electricity works with their patent non-conducting composition. All the pipes, &c., in the power house at Messrs. Milnes' Hadley car works, which we illustrated in our issues of 8th and 15th insts., are also covered with material of the same description.

Catalogues and Lists.—Messrs. Davis & Timmins, Ltd., of King's Cross, have sent us a copy of one of their latest lists of screws, terminals, bolts and nuts, battery clamps, studs, and other like accessories for electrical work.

"Mr Smith, of New York" has sent us one of his wall circulars (No. 20) of electric railway and tramway lighting appliances.

Messrs. Davey, Paxman & Co. have issued an illustrated catalogue (January, 1901) of their steam engines, boilers, and other machinery. Among the illustrations is a three-cylinder Windsor vertical engine with dynamo combined. There are numerous woodcuts and other illustrations, these including both general and sectional views. There is an appendix covering a dozen pages giving information of a general kind in handy tabulated form ready for the use of engineers.

From Messrs. John Spencer, Ltd., of Wednesbury, we have received a new and revised list of tubes and fittings.

Messrs. Maguire & Baucus have issued a new circular of their "phono-electric" wire, and other specialities for electric tramways.

Messrs. Bradbury & Co., Ltd., of Oldham, have issued a number of new illustrated lists of their capstan lathes, also their hollow mandrel lathe, radial drilling machines and universal bench grinding machines.

The B.T.H. Co.'s pamphlet, No. 90, is devoted to a description of the type O.K. ampere-hour meter for continuous current circuits.

Dissolutions and Liquidations.—Messrs. S. Williams and T. Harrison (Williams & Harrison, electrical engineers, Southport) have dissolved partnership. Mr. Williams will attend to debts.

In *re* A. I. Greenberg (Midland Electrical Company, Birmingham): first meeting, April 3rd; public examination, April 29th.

In *re* J. E. Bunce, electrical fittings manager, Halifax: first meeting, April 3rd; public examination, April 29th.

On Wednesday the petition of John Sewell for the compulsory winding-up of the Westminster Automatic Telephone Syndicate was before Mr. Justice Wright in the Companies' Winding-up Court. Counsel for the petitioner admitted that the debt had been paid, but in view of other eventualities, the petition was ordered to stand over for a week.

The petition of C. E. Foster and others for the compulsory winding-up of the London Electrical Cab Company, Limited, was before Mr. Justice Wright in the Companies' Winding-Up Court on Wednesday. Mr. Counsel, who appeared in support of the petition, said it had been put on the list at the request of the Receiver appointed by the provisional liquidator. The case was before his Lordship in October last, and he now had the report of the Receiver. He proceeded to read the report, which stated that efforts had been made to procure a purchaser of the licences which formed the assets of the company, but up to the present an offer of £25 was all that had been suggested. There did not appear to be any possibility of obtaining an offer for the assets. The nominal capital of the company was £150,000 in £1 shares and 101,331 shares have been issued. There were also 15,000 debentures. The company was promoted by the Traffic Syndicate, Limited. It would be in his Lordship's recollection that in not granting the order for compulsory winding up in October he said that the petitioners were entitled to an order if it were not injurious. His Lordship: What do you mean by injurious?—Mr. Counsel said he meant injurious to the company or the debenture-holders. His Lordship then stated that the ground relied upon by the opposition was mainly that the petition would be injurious to the realisation of the assets of the company. His Lordship: What do you want?—Mr. Counsel: An order for compulsory winding up. Mr. S. Smith appeared for the company, and there were other counsel present representing shareholders and debenture holders. Mr. Counsel said they had got the petition put in the list; so that his Lordship might consider what bearing the Official Receiver's report would have on the matter.—His Lordship: The Official Receiver's report shows that there are no assets.—Mr. Counsel said it came to this, that unless assets could come from the winding-up, there would be none. His Lordship: Then it is of no use applying for an order. Are you applying for anything except a compulsory order?—Mr. Counsel said he was not quite sure what the position was. He asked that the petition should stand over, with liberty to apply. His Lordship said he had decided on the merits that there were no misfeasance assets to come in, and the Official Receiver had satisfied him, and there were no tangible assets; the petition would, therefore, be dismissed with costs, but if Mr. Counsel made a fresh application, founded on material, he would hear it. There had been charges of fraud insisted on, and therefore he should allow the costs.

Electric Driving.—The Barrow Steel Company has recently put down five electric motors for working its auxiliary machines. The directors are complaining that owing to the small quantity of rail orders received during the year, they have experienced some difficulty during the latter part of the year in keeping the mills in continuous and full operation.

Fire.—We regret to announce that the works of the Conduit and Insulation Company, Limited, at Summers Town, S.W., have been visited by fire. The old premises and equipment have been completely destroyed, but the new buildings recently erected at either end were saved. Fortunately, in these new buildings the raw and finished materials were stored, so that there will be no difficulty in meeting ordinary business; but it is hoped that the trade will exercise as much consideration as possible in regard to special work, as the manufacturing plant will practically have to be expressly re-designed, and there may be some delay in contracts of this class for the next few weeks.

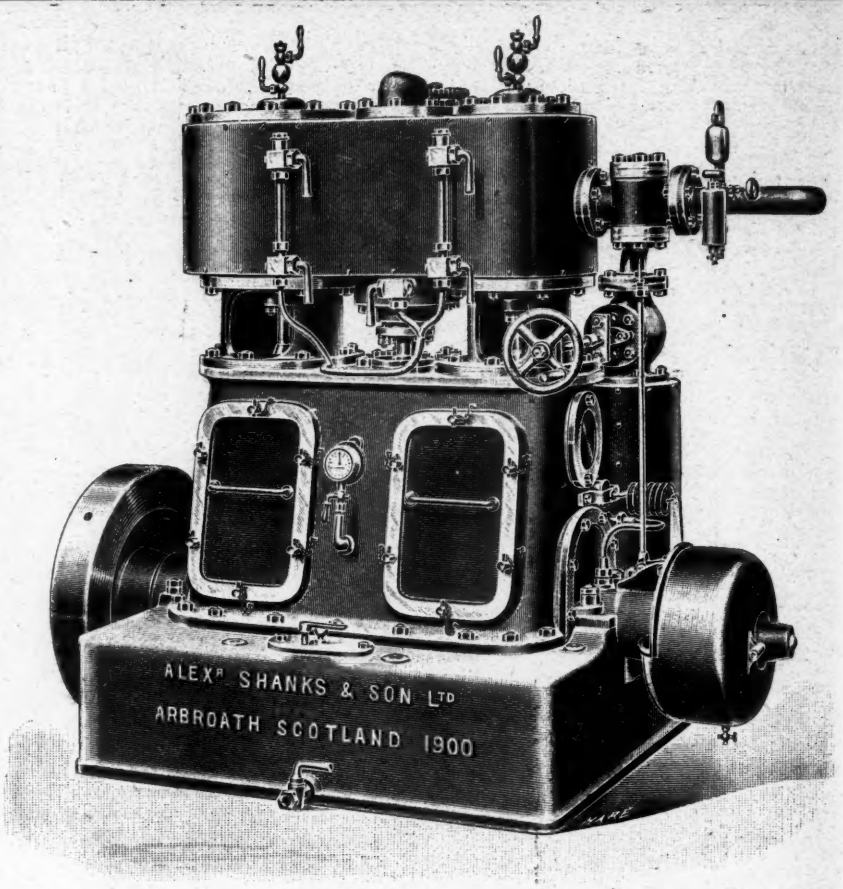
Gear Cutting.—Messrs. John Smith & Co., of Grove Works, Carshalton, have recently put down special plant of the latest type for the production of machine-cut gear wheels, and have issued a price list for cutting teeth. They claim to have facilities for cutting spur wheels, and for planing the teeth of bevel wheels to correct form, up to 6 ft. diameter in each case, and they work to Brown & Sharpe's standards for involute teeth to ensure accuracy and despatch. A large stock of wheel patterns is kept.

Trade Announcements.—In consequence of their Collier Street premises being required by their neighbours, The Hub Two-Speed Gear Company, Limited, for extension purposes, Mercier's Patents, Limited, are removing to new works at 252, Chapel Street, Salford, on April 4th next.

Owing to the considerable increase of business in the Midlands and the North, the Hart Accumulator Company, Limited, have opened an office in Manchester at Temple Chambers, 33, Brazennose Street.

The Electric Lighting and Traction Company of Australia, Limited, is removing on April 1st, 1901, from 49, Queen Victoria Street, E.C., to St. Mary Abchurch House, 123, Cannon Street, E.C.

Shanks's Enclosed Engines.—We illustrate herewith an enclosed engine which is an example of the high speed compound double-acting vertical engines manufactured by Messrs. Alex. Shanks & Son, Limited, of Arbroath. These engines are made in sizes ranging from about 30 B.H.P. upwards, for speeds up to 600 revolutions per minute, and are suitable for steam pressures of 100 lbs. to 160 lbs. per square inch. They are arranged with large bearing surfaces lined with white metal to admit of continuous running, and all journals are lubricated by means of "forced lubrication," the oil being forced into the various bearings at a sufficient pressure by means of a special valveless pump. The sole plate is arranged to collect the oil after it has been used, it then being carefully filtered before it is again taken up by the pump. All the working parts of the engines are enclosed in strong castings forming the frames. The valves are of the simple piston type, each driven by its separate eccentric, and arranged between the cylinders. To obviate the risk of water being suddenly carried into the cylinders, a separator with trap is usually fitted by the makers. The governor supplied is of the crankshaft throttle type, and is capable of regulating the engines to within 3 per cent. between full load and no load. We understand that great attention has been paid to the construction of the various details in order that everything should be of the highest class.



Shanks' Enclosed Engines.

Brussels Electricity Works.

Brussels Electricity Works.—In our "Contracts Closed" last week (page 505) we stated that La Compagnie Internationale d'Electricité of Liége had just secured an order for a 100-H.P. steam dynamo for the extension of the Brussels central electric lighting station. We understand that the set is of 1,000-H.P. and not 100. The company have already put up two steam dynamos of 1,000-H.P. each in the central electric lighting station of Brussels, and some steam dynamos in the electric tramway station of the same city. Each 1,000-H.P. steam dynamo is able to give 1,300-H.P. during a certain period of time. We learn that the two 1,000-H.P. steam dynamos already in use (one of which we show in our illustration) have been running without interruption, and free from the least trouble, since October last year.

Electrical Developments in the British West Indies.—A cablegram has just been received, says the *Electrical World*, from the British Colonial Government of the Island of Trinidad by Mr. W. B. Chapman, of Montreal, representing the Trinidad Electrical Company, which is composed of Montreal capitalists, stating that the Colonial Office has consented to the granting of a charter to the company for the construction of an electric tramway line and an electric lighting plant in the city of Port of Spain, the capital of the island. The Trinidad Electric Company some months ago obtained control of the existing tramway lines and lighting plant in Port of Spain, and made application for a charter to convert the tramway lines into electric trolley lines, covering the entire city. The charter also asked for power to extend the lighting plant to all parts of the city, and its adjacent suburbs. This application was dealt with by the Colonial Government of the island, and referred to the Imperial Government for ratification. This has been given, and the company now has a charter under which it proposes to expend some $940,000 in acquiring existing tramway and lighting plants and converting them into a system covering the whole of the city of Port of Spain and three adjacent suburbs. The new company, which will shortly meet for organisation purposes and election of officers, will be capitalised at over $1,000,000, and the work of construction will be commenced in the course of a few months. Already Messrs. Bruce and McConnell, engineers in the employ of the new company, have gone over the ground and prepared plans and specifications of the work the company proposes to undertake. The existing plants, which the company will take over, include a good electric plant with a mile and a

half of poor tram-line, and a small lighting system. There are also about eight miles of good mule-car line in and outside the city. The Island of Trinidad is the most prosperous of all the British West Indies. There is reason to believe that resort will be had to the American market for much of the material required.

Bankruptcy Proceedings.—The sitting for the public examination by the Official Receiver of the partners in the firm of Johnstone, Benjamin & Co., electric wire and cable manufacturers, late of 10, Ascham Street, Kentish Town, was held on Wednesday, at the London Bankruptcy Court, before Mr. Registrar Giffard. The accounts filed by the debtors showed total liabilities £8,116 3s. 11d., of which £7,480 7s. 8d. is expected to rank, against assets valued at £5,911, and consisting mainly of shares in Johnstone, Benjamin & Co., Limited.

Mr. Ernest Benjamin was first examined by Mr. E. L. Hough, Senior Official Receiver. He stated that he commenced business about 10 or 12 years ago as a dealer in metals, under the style of Johnstone & Benjamin. He adopted the name of Johnstone because it resembled a well-known name in the trade. In 1892 he added the business of manufacturer of electric wires, and was subsequently joined by his cousin, who introduced £300 capital, and became an equal partner. They traded together as Johnstone, Benjamin & Co. until last December, when, under an agreement dated 22nd of that month, they transferred the business to a limited company, styled Johnstone, Benjamin & Co., Limited. The agreement provided for the transfer of the lease, goodwill, stock-in-trade, and book debts. It was subsequently modified by the exclusion of certain book debts, which were regarded as of doubtful value. That was done at the instance of the promoter, a Mr. Phillips, who was a brother to witness's partner, Lewis Benjamin.

The Official Receiver: May I take it that the company purported to buy everything of value that you possessed?

Witness assented to that view. The company was formed with a nominal capital of £15,000, and the purchase price was agreed at £9,200, made up as follows:—£500 cash, £5,000 deferred shares, £1,500 ordinary shares, and £2,200 debentures. The stock taken over by the company was valued at £2,902, and was based on the market prices of the day. The machinery, plant, utensils, &c., were taken at £2,542, the book debts at £2,004, the lease at £1,000, the goodwill at £575, and there was cash at the bank £395. The £500 cash portion of the consideration was handed over to the promoter; witness transferred £900 debentures to the trustees of his marriage settlement; his partner made a similar transfer of £1,100 debentures, and the other £200 were held as security for a loan of £150 made personally to witness. Then £500 ordinary shares were handed to Mr. Phillips, the promoter; £250 ordinary shares were transferred to the trustees of his partner's marriage settlement, and the other £750 ordinary shares, together with the £5,000 deferred shares, had been handed over to the Official Receiver. The deferred shares were not eligible for dividend purposes until 10 per cent. was paid on the ordinary share capital. He could not state the respective position of the shares in the event of liquidation. That was a question of law.

Mr. Hough: It is not a question of company law so much as of the scheme under which the company was formed. What was your object in forming the company?—To find more capital, and make the business a big concern.

Has that object been attained?—No.

Examination continued: They were promised that the whole of the £15,000 capital should be subscribed, and, in fact, Mr. Phillips showed them letters of promise to that effect. Witness regarded the business as being solvent at the date of its transfer to the company.

The Official Receiver: On what did you base that view?—We were able to sell it at more than our debts.

But you know there is a great difference between paper and golden sovereigns, do you not?—Yes.

Examination continued: The marriage settlements covered in each case their share of the capital and goodwill. Witness did not think they were in difficulties at the time of the conversion, but he admitted that a couple of writs had been served upon him prior to December 22nd. Stock had only been purchased during October, November and December, 1900, for the ordinary requirements of the business. If the books showed the amount as in advance of purchases made during any previous three months the increase must have been due to the larger business done.

The Official Receiver: The stock transferred to the company was taken at £2,902?—Yes.

Are you prepared to deny that your purchases in October, 1900, amounted to £1,119?—I cannot say the amount.

And in November to £2,766?—I cannot say.

And from December 1st to 19th to £1,107?—I cannot say.

Making a total for the three months of upwards of £5,000?—I cannot say.

Examination continued. The books of the business were in the possession of the company. Witness and his late partner were now acting as joint managers for the company at the same salary of £250 a year, that they were receiving before the failure as joint managing directors. The trade creditors were not consulted upon the conversion, although the great bulk of the debts were probably incurred during the latter half of 1900.

The Official Receiver: Then, although a large amount of the liabilities represents stock taken over by the company, none of the persons who supplied that stock were consulted as to the sale?—No.

And the rights of those creditors are confined to the realisation of the paper consideration and the book debts which the company did not take over; the whole of the stock, goodwill, lease, plant and good book debts having, so far as you could do so, been placed out of their reach?—We sold to the company for shares.

Why did you resign the office of managing director?—I had to, under the articles of association, when I had not enough qualification shares.

But you still had the loaves and fishes in the shape of salary as manager?—We had to live.

The Official Receiver questioned the witness at some length regarding the sale to Mr. Garnham of 6 tons 18 cwt. 1 qr. 13 lbs. of new copper wire at £78 per ton, a total of £539 12s. 6d. The debtor admitted that the purchaser paid cash, which was put into their banking account, and that two days later a dishonoured bill for £500 was re-presented by the trustees of his cousin's marriage settlement, and was then honoured. He did not submit the goods for sale as new copper, and, in fact, some of it had been in stock a considerable time.

The drawings of the partners just before the failure were next inquired into by the Official Receiver, who pointed out that the witness drew out £149 at the end of November and during December, and that his partner between December 1st and 19th drew out £113. The witness agreed that the amounts were larger than usual, but he was unable to give any explanation beyond that the money was required for household needs.

Can you point to any one except yourselves, your relatives, and your friends, who have received one penny of benefit out of the formation of the company?—No.

Have you any relative or connection to whom you owed money last December who did not receive payments either in cash or paper in December or January last?

The Witness said he had some relatives abroad to whom he owed money, but he had not included their names as creditors in the statement of affairs. He borrowed considerable sums last November and December for the purposes of the business. The relatives who asked for payment, received it, but the trade creditors did not participate in the distribution.

Mr. Whateley, on behalf of the trustee, further questioned the debtor regarding the constitution of the company, and unsuccessfully endeavoured to elicit an admission that the whole of the shareholders were nominees of the promoter. The witness further stated that he had no interest whatever in a business carried on at Wenlock Road, City Road, under the style of the London Wire Cordage Company.

Have you supplied any goods to them except in the ordinary way of trade?—Not to my knowledge.

Will you swear that you have not?—Not to my knowledge. My firm have supplied goods to them daily.

In reply to Mr. Osborne, the debtor stated that he was married in August, 1893, and that his marriage settlement was entered into before that date. Being in hopes of paying all his creditors in full as the result of selling the business to the company, he did not consider there was any necessity to inform them of the fact. Unfortunately, the capital was not all subscribed, and the creditors were not paid. In addition to paying his family in December, he also paid many of the creditors. Beyond receiving payment as creditors, his firm had no other interest whatever in the London Wire Cordage Company.

Lewis Benjamin, examined by Mr. Hough, stated that he agreed with the evidence given by his partner. He was married in August, 1899, prior to which date a sum of £1,000 was advanced him by his wife, and was repaid by 11 £100 debenture bonds in the marriage settlement.

The examination of both debtors was ordered to be concluded.

Personal.—In our last week's report of the Board of Trade inquiry, we referred to Mr. A. H. Rose as the London manufacturer to the Crystal Electric Lamp and Rose and Bird, Limited. We understand that the "Cryselco" lamps are manufactured *only* at the Bedford works, and Mr. Rose is the company's representative in London.

ELECTRIC LIGHT AND POWER NOTES.

Bournemouth.—The T.C. last week adopted a recommendation from committee with respect to the proposed purchase of the electric light undertaking of the Bournemouth and Poole Electricity Supply Company, Limited, viz.:—That having considered the report of Messrs. Lacey, Clirehugh & Sillar on the proposed purchase, they cannot recommend the Council to offer to company more than £170,000, and they recommend that the offer of this amount be made to the company.

Brighton.—Mr. H. H. Law, M.Inst.C.E., L.G.B. inspector, held an inquiry on Friday last with respect to the application of the T.C. for sanction to borrow £19,600 for electric lighting purposes. The town clerk explained that £6,400 of the above sum was required for street lighting by means of electric arc lamps, and separate sanction was necessary for the borrowing of this amount. It was proposed to erect 107 arc lamps, displacing some 133 incandescent lamps and 48 gas lamps, the change being proposed for the better lighting of the electric tram routes, when completed. The electrical engineer, Mr. J. Christie, stated that it was proposed to utilise the poles for the overhead trolley wires of the tramways for the purpose of supporting the lamps. The town clerk stated that £13,200 was for the purpose of supplying the extra power required for the trams. Mr Christie explained that the machinery, which would cost about £7,790, would consist of three sets of steam-driven dynamos, direct coupled, one set of 325 kw. and two small sets of 175 kw. each. No opposition was offered.

Bradford.—The Electricity Committee has received sanction from the L.G.B. to the borrowing of £140,000 for lighting and traction extensions. The letting of contracts for works extensions, amounting to £21,937, has been approved by the Council.

Burnley.—The T.C. has resolved that application be made to the L.G.B. for sanction to the borrowing of £10,200—£8,070 for proposed extensions to the electricity supply works, and £2,130 for expenditure on electric lighting in excess of borrowing powers.

Colliery Installation.—The owners of Wallyford pit, the Edinburgh Collieries Company, Limited, have decided to do away with steam power underground and to replace it by electricity. A contract for the work has been placed with a Glasgow firm.

Dumfries. — Mr. John Ritchie, hydraulic engineer, Edinburgh, who made a survey in the neighbourhood of Dumfries and district on Friday and Saturday with a view to reporting on the possibility of utilising water power for the proposed electric installation, has not yet submitted his report; but it is understood that his observations of the Glen Stream satisfied him that the river with auxiliary sources of supply, which could easily be utilised, would be ample to furnish 350 H.P. operating turbines with a fall of some 180 ft.

At the Glen Mill, even when the Cargen Burn is low, 100 H.P. can easily be obtained. A natural gorge exists, and with a simple arrangement of dams this power could be trebled. The Milton Loch could then be tapped for further extensions.

Dundee.—The income from electricity for the nine months ended January 31st, was £7,455, and in February £451, being an increase on the 10 months of £1,873 over the corresponding period of the previous year.

Greenock.—At a meeting of the T.C. last week the Electricity Department accounts were again submitted, but owing to some objections set forth by the auditor they were again remitted back to committee for adjustment. The borrowing powers are £100,000. Of this £50,000 has been borrowed, and £833 has been repaid out of sinking fund. Under capital account the expenditure amounts to £40,770. From the sale of energy a balance of £764 is shown as having been carried to net revenue account. It was stated at this meeting that an account for the supply of energy of £18 4s. 7d. had been settled by payment of £4 6s. 2d.; also that another account of £20 1s. 0½d. had been settled by payment of £2 7s. 8d.

Ham.—At the meeting of the U.D.C. last week, a letter was read from Mr. Clifton Robinson, managing director of the London United Tramways, Limited, offering to enter into a contract with the Council for the "immediate supply" of electric current for lighting and power. The terms offered were a maximum of 4d. per B.T.U. In reply to a letter from the clerk, Mr. Robinson explained that the word "immediate" meant that the company would be prepared to enter into immediate arrangements for an electric lighting supply.

Haslingden.—The surveyor is to get out plans and estimates for a destructor and electric lighting station.

Kimberley.—At the Borough Council meeting on the 28th ult. the mayor stated that the private electric lighting system, the installation of which had cost a trifle under £25,000, would, it was anticipated, show a loss of some £2,000 on the year's working, and it was proposed to raise the cost per unit from 1s. to 1s. 4d. as and from May 1st. A resolution was adopted to the effect that the borough electrical engineer furnish a statement showing the cost to the Council in respect of connections made from the mains to private premises, distinguishing in each case—(1) Value of cable used; (2) service and fuse boxes; (3) labour, together with a comparison of this with the various accounts rendered for connections to the consumers.

London.—SHOREDITCH.—The Lighting Committee has received a report from Mr. Newton Russell, chief electrical engineer, with regard to an improved method of destroying refuse. It appears that the main object in view is to reduce the amount of residue and incidentally to produce a much more useful clinker. A preliminary experiment in this direction has already been carried out with satisfactory results, and it is now proposed to go further into the question by the erection of an experimental furnace on a larger scale. The Lighting Committee have also considered a report by the engineer on the subject of the extensions of mains required during the ensuing year. The extensions are necessary in the first instance by reason of the new station being erected in Whiston Street, and new feeders are needed in the Wenlock and City Road districts. It is estimated that the expenditure will at least amount to £15,700, and the work is intended to be carried out during the next 12 months.

LONDON COUNTY COUNCIL.—The Council, at the meeting on Tuesday, decided to advance a loan of £30,000 to the Hackney Borough Council for electric lighting purposes, and £13,530 to the Hammersmith Borough Council for similar works. The Finance Committee stated that the Stepney Borough Council had applied for sanction to borrow £5,163, repayable within 28 years, for the lighting of the streets by electricity. The treasury authorities had intimated that, in their opinion, no longer period than 20 years could properly be sanctioned for that class of work, and it was decided to sanction the loan for that period of years.

BERMONDSEY.—The Borough Council has resolved that for ordinary lighting the maximum demand system be adopted at an initial charge of 6d. per unit, and 3d. per unit afterwards; that for churches and chapels a uniform rate of 3d. per unit be charged; and for power a uniform rate of 2½d. per unit. It was also decided to charge 3d. per unit for street lighting.

MARYLEBONE.—The Lighting Committee last week presented a special report informing the Council that the B. of T. had granted prov. orders to generate and supply electricity, to the Borough Council and to the Marylebone Electric Supply Company, subject to confirmation by Parliament.

Newport.—Col. Luard held a L.G.B. inquiry on Tuesday into the application of the Corporation for sanction to borrow £28,000 for electric lighting purposes. The town clerk gave statistical evidence to show the progress of the undertaking since it was started in 1895. After payment of sinking fund and interest, there were deficits for the first four years, as follow:—1896, £1,410; 1897, £962; 1898, £434; 1899, £293. In 1900 there was a net profit of £403. This year there would be a deficit, though the amount could not be stated yet. The present application was partly to meet excess of expenditure and partly for proposed expenditure. The amount of the loans sanctioned at present for electric lighting was £80,815. £10,000 of the proposed expenditure was for new mains, sub-stations, and transformers, and £5,121 for changing the system from 100 volts to 200 volts.

The electric light is to be extended to working men's dwellings to be erected shortly.

Richmond and District.—At the invitation of the B. of T. a conference was held last week at Whitehall, between representatives of the Richmond, Ham, Teddington, Hampton and Hampton Wick local authorities in reference to an application for prov. orders affecting these districts by the Richmond Electric Light and Power Company. The B. of T. declared that the applications affecting Teddington and Hampton could not be proceeded with, whereupon the representative of the company, Mr. Morse, announced that the applications would be withdrawn. Meanwhile the Teddington and Hampton District Councils will proceed with their respective applications for prov. orders.

Shannon Power Scheme.—A conference of representatives of local authorities was held last Saturday to consider the Shannon Power Bill.

Sheffield.—The Sheffield Chamber of Commerce last week resolved "That this Chamber, having considered the Bill of the Electric Power (Yorkshire) Company, do hereby declare that, in their opinion, the company's Bill is conceived in the best interests of the commerce and industry of this locality, and that it must be of great advantage to traders generally that central power stations should be established for the generation and distribution of electric power for motive and general manufacturing purposes at the lowest possible cost."

Last Saturday evening the public electric light supply failed for some time.

Stoke.—Messrs. Peers & Trentham, electrical engineers, Manchester, have been engaged to make a report on the proposed electric light installation at Stoke-on-Trent.

Thanet.—The Joint Hospital Board has resolved to call in an expert to report on the question of supplying the hospital with electricity.

ELECTRIC TRACTION NOTES.

Austria.—Negotiations for the construction of an e tric railway between Vienna and Pressburg between Messrs. Siemens & Halske and the Austrian Government have practically been concluded. Three central power stations are to be established in connection with the line, one in Vienna, one in Hainburg, and one in Pressburg.

Brighton.—The Tramway Committee has approved the engineer's plans and specifications for the erection of the car shed and offices at an estimated cost of £9,360, and has ordered the work to be proceeded with without delay.

France.—It is understood that work upon a new service of electric trams is to be commenced in Menton, Department of the Alpes Maritimes, in May. In addition to the urban system a line will be laid from Menton to Cape Martin.

A new electric railway is projected from Grenoble to and beyond Laffrey. The route of the line contemplated is along the left bank of the Pomanche from Sechilienne to the great bridge of Vizelle, from which, along an embankment, it would reach Grenoble *vid* Jarrie and Eybens.

Italy.—A Commission has been appointed by the Italian Minister of Public Works to examine a project of the engineer, Farina, of Milan, for the construction of an electric tramway from Varallo to Alagna, the cost of construction of which is estimated at 900,000 lire.

Kinver.—By means of the new electric railway this beautiful Black Country pleasure resort has now been brought into direct and rapid communication with Stourbridge, and thence with Brierley Hill, Dudley and the district. The line was inspected on Friday last week by Col. Yorke, R.E., on behalf of the Board of

Trade, and in presence of a numerous company of officials connected with the governing bodies through which the railway passes, as well as the officials of the British Electric Traction Company.

London Underground Railways.—In the House of Lords last week on the motion of the Earl of Morley, chairman of Committees, it was resolved that a committee consisting of the Earl of Lauderdale, the Earl of Rosse, Viscount Knutsford, Lord Windsor, and Lord Herries be appointed to join with a Committee of the House of Commons to consider and report:—

(1) Whether the lines of route for underground railways in and near London proposed by Bills which have been or may be introduced during the present Session are best calculated to afford facilities for present and probable future traffic; and, if not, what modifications of those lines of route are desirable. (2) What special provision, if any, should be made for the protection of the owners, lessees, and occupiers of properties adjacent to underground railways from possible damage and annoyance. (3) What special terms and conditions, if any, as to construction and working should be imposed upon the promoters. (4) Whether any, and which, of the schemes proposed by the said Bills should not be proceeded with during the present Session.

We read in the *Yorkshire Post* that the British Westinghouse Electric and Manufacturing Company, Limited, has withdrawn the Bill which it lodged with Parliament last November in regard to the electrification of the inner circle of the Metropolitan and Metropolitan District Railway Companies before it has reached the Committee stage.

Lyndhurst (New Forest).—Earl Jersey and Col. Boughey, Light Railway Commissioners, held an inquiry at Lyndhurst on the 20th inst., as to the expediency of granting an order for the construction of the Lyndhurst Light Railway. Mr. Bartley Denniss, counsel for the promoters, stated that the proposed line was between Lyndhurst Road Station and Lyndhurst, and just over 2½ miles in length. There was no gas or public lighting of any kind at Lyndhurst, and it occurred to the promoters of the order that they could run an electric lighting scheme together with the light railway scheme. Mr. C. J. Wharton, engineer to the company, said that the greater part of the line would now be on sleepers instead of concrete, which was proposed when it was intended that the line was to go by the side of the road. He estimated the cost of the construction at £15,000, with £15,000 for rolling stock, electrification, and generating station, which he thought would have to be found by the electric light company, as the two companies would have a separate capital, and the railway would have to take the motive power from the electric light company. He thought they would be able to pay 7 per cent. on £34,000, the estimated outlay. Mr. Charles Bright (Bright & Co., Limited) said his company was in a position to finance the proposed railway scheme, which, he thought, would be a commercial success. There was no opposition, and Earl Jersey said that they would have no hesitation in recommending the Board of Trade to accede to the application.

Manchester.—Prof. Kennedy attended a special meeting of the Electricity Committee last week to discuss the best method of carrying out the Committee's decision to provide a temporary station for the generation of electricity wherewith to work certain sections of the Corporation electric tramways provisionally until the permanent station in Stuart Street can be completed and brought into operation. The turbine principle was spoken of, but Prof. Kennedy favoured engines of the reciprocating type, and advocated that engines of about 5,000 H.P. should be erected for provisional purposes. He was authorised by the Committee to prepare a plan and specifications for the construction of the temporary station upon a portion of the land purchased as the site for the Stuart Street works. A strong desire was expressed that the plant might be ready to take up its load in May, 1902, so as to enable the Tramways Committee to fulfil their already somewhat deferred agreements with the Carriage Company and certain outside authorities.

Mersey Railway.—At last week's meeting of this railway company, Mr. James Falconer, who presided, in speaking of the future of the undertaking, remarked that the proposed change from steam power to electric traction was by far the most important question that they had to consider. It was the end and object of their whole policy, but, as those who had been taking any interest in electrical questions would know, it was a subject surrounded by many difficulties. The form of electric traction best suited for a full-size railway tunnel like theirs had not yet been determined by experience in this country. By their Act of 1900 the company would be able to place the stock which would be required for the purpose of paying for the electrical works in front of the existing perpetual debenture stocks. No impatience to proceed with the change of traction, however, must make them lose sight of the great importance to this company of securing the best system and the best terms, for they could not afford to make a mistake in this matter. The Wirral Railway Company had also obtained powers to convert their system of working from steam to electric traction, and the board were in communication with the directors of that company with the object of arranging mutually satisfactory terms for a joint system of electric working.

Middleton.—The B. of T. have sanctioned the application of the T.C. to borrow £37,000 for the construction of about three miles of electric tramways from the Manchester boundary in Manchester New Road to Middleton Junction, and also for the erection of a generating station in Middleton.

Overhead Wire Dangers.—Mr. R. A. Chattock, the city electrical engineer, and Mr. C. J. Spencer, the tramways manager, of Bradford, have together drawn up a set of rules for the use of the police there in the event of accident arising in connection with the overhead trolley wires. As these may be of some interest to other tramway officials, we print them in full:—

1. In the event of telephone or telegraph wires falling and making contact with the overhead trolley wire, or in the event of the trolley wire or its guard wires falling, all traffic should be stopped, and the public prevented from approaching the fallen wires.
2. The fallen wires should on no account be interfered with by the police or any unauthorised person unless for the purpose of saving life or protecting persons from being injured, as explained in Rule 5.
3. Notice should be at once given to the nearest car driver, who will take steps to cut off the current. If one is not available notice should be at once sent to the nearest tramway depôt by telephone, or messenger in a cab, with a request for someone of authority to proceed at once to the spot to deal with the fallen wires. These depôts are as follows:—Forster Square, Tyrrel Street, Horton Bank Top, Bolton, Whetley Hill, Thornbury, and Fairweather Green.
4. Drivers of cars should not be called upon to interfere with the fallen wire unless it is for the purpose of saving life or preventing persons from being injured.
5. If the fallen wire is in contact with any person, and it is necessary to remove it at once in order to save life or prevent injury, the following points should be remembered:—The person removing the wire should (*a*) never touch it with his hands; (*b*) never touch the skin of the person in contact with it; (*c*) use a dry stick, dry rope, or article of dry clothing* to drag the wire away with, or to drag the person away from the wire; (*d*) use india-rubber gloves for pulling the person away from the wire, it being safest not even to touch the wire with them; (*e*) in case it is impossible to get the wire away from the person, the wire should be dragged to the nearest tramrail and held down upon it in order to discharge the current from it, or the wire should be cut by means of insulated shears, which can be procured from the cars. Gloves should be worn when these are used.

* Note that it is very important that any article used for this purpose should be dry; a wet article will convey the current, and probably give the person handling it a shock.

6. Each car will carry a pair of india-rubber gloves and a pair of insulated shears, which will be kept in a glass-fronted box in a prominent position. The same will be kept at each tramway depôt, each police station, and each fire station. Gloves should always be used where possible.

Penge.—A scheme has been brought before the Council by private promoters, who intend to deposit a Bill for the construction of an electric tramway affording—(1) Direct communication with Croydon; (2) easy access to Crystal Palace. The matter was referred to the special meeting of the Council in committee.

Poole.—Last week Major Pringle (Board of Trade) officially examined the electric tramway system which has been constructing for some time by the Poole and District Electric Traction Company, Limited, and is now ready for official inspection. The electric cars have been already run, more than once, over the entire route. Directly the Board of Trade certificate has been obtained the Electric Traction Company will prepare for the actual daily running, which will probably commence on or about April 5th. The system connects Poole with Parkstone, Constitution Hill, and Bournemouth, as far as about a mile from the Bournemouth West Station, *i.e.*, to the west boundary of the county borough. By arrangement this line will join the new system of the borough, which is to be completed in less than two years.

Portsmouth.—Major Pringle, R.E., B. of T. inspector, held an inquiry last week in reference to a proposed loan of £327,134 14s. for Portsmouth tramway purposes. It was explained by the town clerk that this loan would not include the sum to be paid to the tramway company, which had to be decided by Sir F. Bramwell, the arbitrator. The cost of the power station was to be £11,400, of which £900 was for the site. Car equipment accounted for nearly £49,000, the contract for the reconstruction was £202,000, and for the overhead work £18,000. There was also a sum of £30,000 for car sheds, and various other smaller amounts, which, with 5 per cent. added for contingencies, made up the aggregate of the loan. Mr. E. Rotter, tramway engineer and manager, stated that the total length of the lines would be equivalent to 28 miles, distributed over 14½ miles of road. Nearly all the lines would be double, but about 1½ miles would be interlacing, and one-third of a mile single track. The extensions would be four miles in length. The cost per car would be nearly £600. There was no opposition.

Preston to Lytham.—Plans are being prepared and a survey is being made for the construction of a light railway from Preston to Lytham. The scheme has been submitted to the authorities at Lytham this week, as is approved, subject to certain minor deviations of route. The engineer who is preparing the scheme is also engineer of the Electric Traction Syndicate, which is negotiating for the purpose of the Blackpool, Lytham and St. Anne's tramways. When the scheme is fully carried out there will be the system of electric traction from Preston *vid* Lytham, St. Anne's, South Shore, Blackpool, Cleveley and Rossall to Fleetwood.

Richmond (Surrey).—Last week the Corporation Tramway Committee considered the details of a scheme of local tramways suggested to be promoted by the T.C. in conjunction with the Barnes U.D.C. and the Richmond Electric Lighting and Power Company. The Committee decided not to fall in with the scheme and to continue their opposition to the L.U.T., pending the existing negotiations, on the basis outlined by Mr. Clifton Robinson at the meeting of tradesmen.

Scarborough.—Our local correspondent says that instead of electric tramways for Scarborough, "we are promised a service of motor cars. With regard to the tramway company's project, this has been thrown aside by Parliament, and with respect to the Corporation, no action is likely to be taken for some time, as that body has plenty of irons in the fire at present. Messrs. Walker & Hutton, local electrical engineers, recently suggested that a service of motor cars should be adopted, and the suggestion has been so readily approved, that a limited liability company is now in course of formation, with a capital of £2,500. It is proposed to start with three cars of 13 H.P., each capable of drawing heavy loads up the steepest gradients; they are to be so arranged, that they may be used as ordinary street cars or as char-a-bancs to run on the numerous pleasure drives in the season, and as omnibuses in the winter season. The scheme appears to be warmly supported, and the promoters are sanguine as to being ready for business before the end of July."

Switzerland.—The Simplon Railway Company has secured a concession from the Italian Government to utilise the water-power of the Diveria River. About 600 H.P. is said to be available, and the power generated will be used for the electrical propulsion of trains through the Simplon Tunnel.

Spain.—La Compania de los Tranvias de Bilbao à Durango y Arratica has entrusted the Thomson-Houston Mediterranean Company with the carrying out of its electric traction scheme. The lines will be 18 kilometres in length, 16 kilometres of which will be double track.

TELEGRAPH AND TELEPHONE NOTES.

Brighton Telephones.—At a committee meeting held on 11th inst., the town clerk submitted the amended draft proposed to be issued by the Postmaster-General conferring upon the Council the power to carry on telephonic business. The period of 25 years over which the license is to stand is now made to commence from March 1st, 1901, instead of November 1st, 1900, and the area within which the delegation of wayleave powers is to take effect now comprises the whole of the telephone area. The committee resolved to approve the draft and ask the Postmaster-General to fix May 1st as the date for the commencement of the term. On March 14th the committee resolved that the town clerk write to the town clerk of Hove, stating that the committee understand that the Hove Council are about to lay wood paving along Church Road, Hove, and requesting them at the same time to lay telephone ducts for the purposes of the new telephone system, and stating that the committee recommend the Council to defray the cost of providing and laying such ducts. Mr. Holliday, the tramways engineer, was consulted as to the cost, and stated that he estimated the cost of the ducts at £390 and the necessary manholes at £45, and it was resolved that the Council are willing to defray the cost of the work.

The Cable Communications Committee.—A meeting of this committee was held on 19th inst., when evidence was given by Mr. B. T. Ffinch, Director-in-Chief of the Indo-European Telegraph Public Works Department, and Mr. C. H. Reynolds, late Director-General of Telegraphs in India.

Another meeting was held on 26th inst., when evidence was given by the Hon. W. Mulock, K.C., Postmaster-General of Canada; Mr. F. A. Bevan, chairman of the Anglo-American Telegraph Company; Mr. Underdown, K.C., chairman of the Direct United States Company; Mr. Charles Burt, director of the Anglo-American Telegraph Company; and Mr. A. S. Baxendale, Superintendent of Posts and Telegraphs at Selangor.

Canada and State-owned Cables.—The Hon. William Mulock, Postmaster-General of Canada, who left London yesterday on his Australian mission, had an interview with Mr. Chamberlain at the Colonial Office last week. He was invited by Lord Balfour of Burleigh to submit to examination before the Inter-Departmental Committee on the System of Cable Telegraphs of the Empire. Mr. Mulock expresses himself particularly interested in a direct cable system between Canada and the United Kingdom. In the Canadian Senate, on the 7th inst., Sir Mackenzie Bowell, Leader of the Opposition in that House, gave notice that he would move for copies of the tenders and contract for laying the Pacific cable, and all correspondence in connection with the nationalisation of the cables of the Empire. He proposed to move this in anticipation of the Bill which would be laid before them in a few days.

Cable-cutting in War-time. — In the House of Commons on Tuesday last Sir J. Colomb asked the Under Secretary for Foreign Affairs whether he would cause to be presented to this House, as soon as possible, a copy of the Code of Law issued by the Navy Department, and signed by the President of the United States, concerning matters relating to the cutting of submarine cables in war.

Lord Cranborne, in reply, said inquiry will be made through his Majesty's Ambassador at Washington as to whether there is any objection to publishing the rules in the United States Naval War Code relating to submarine telegraphic cables. If not, I shall be happy to give the hon. and gallant member the information he requires.

French Cable.—It is stated that an "all-French" cable is to be laid to connect Marseilles, Tangier and Oran.

Hull Telephones.—The National Telephone Company has just completed new headquarters at Hull.

International Telephonic Communication.—Negotiations are reported to be in hand between the German and Russian Governments, with reference to the establishment of a telephone line between St. Petersburg and Berlin.

Liverpool Telephone Wires.—The work of placing the telephone wires underground is now being pushed on rapidly in Liverpool by the National Telephone Company. At the last meeting of the Health Committee of the Liverpool City Council several fresh plans for clearing areas of telephone wires and placing the wires underground were submitted by the telephone company and approved of by the committee. The plans related to parts of Stanley Road where wires crossed the electric tramway tracks. We are informed by our local correspondent that the recent fall of a telephone pole in Wavertree Road has caused much favourable comment in the city as to the stability of the overhead equipment of the electric tramways. The pole was about 60 feet in length and of nearly a ton weight. When being removed by means of a derrick, the pole slipped and fell across the trolley wires. The current was shut off and the traffic was suspended on the route for two hours. The trolley wires well resisted the impact of the pole and the strain of it until it was removed. The knowledge of this has had a reassuring effect on the public mind.

Religion and Telephony.—On the occasion of a recent small-pox epidemic at Mt. Pleasant, Michigan, a number of the churches were closed on Sundays, and were connected with the houses of the members by telephone. One of our New York exchanges also notes that a Methodist evangelist, when conducting a revival, preached his sermons over the telephone, and his appeal "held the auditors glued to the receivers because of its force and eloquence." At the end of the discourse someone telephoned straight away that he "had been converted." Of course, this had to be announced from the pulpit. Whether the message came from a hoaxer or not is not known to this day, for no clue can be gained as to the identity of the particular convert! It is refreshing for Londoners, who so often have occasion to pour vials of wrath upon the telephone, to hear that it is useful somewhere.

Tunbridge Wells Telephones.—A L.G.B. inquiry was held last week in respect of an application made by the T.C. for two loans; namely, £1,800 for street improvements, and £10,000 for establishment of a municipal telephone system.

Wireless Telegraphy.—In the House of Commons on Tuesday, in reply to Sir J. Leng, Mr. Arnold-Forster said: "The *Ophir* is not fitted with wireless telegraphy apparatus. Wireless telegraphy has been in use in his Majesty's Navy for some time, and it is not expected that any special information will be derived from the operations conducted by the cruisers accompanying the *Ophir*, or that any report upon the subject would be of value. Thirty-six of his Majesty's ships have installations of wireless telegraphy, and arrangements are in progress for installing the apparatus on other ships."

The *Standard* Berlin correspondent says that a small detachment of the Telegraph Battalion has been making successful experiments with wireless telegraphy from the chimney of the electric railway station near the Potsdamer Station, to Friedenau and Steglitz, two small towns about six and 12 miles distant respectively from Berlin.

A Central News New York telegram dated March 23rd, says that the Circuit Court has decided that Signor Marconi's wireless telegraphy patent is good, and has dismissed the action for infringement brought by the assignee of the Dolbear patent.

Wireless Telegraphy in the Hawaiian Islands.—It has been erroneously reported that the Hawaiian Islands are connected by cable, and that telegraph communication is now accelerated by the use of the wireless telegraph. The *American Electrician* has fallen into the error, as is shown by the following taken from the February issue:—

"According to a press dispatch, three wireless telegraph stations have been established in the Hawaiian Islands—one at Honolulu, one at Hilo, and one on the island of Lanai. There is a cable connection between the islands of Lanai and Maui, and the establishment of the wireless telegraph service completes means of communication between all the islands of the group except Kauai. It is said that several rigid tests have demonstrated the entire practicability of the system.

"Manager Waller, of the Metropolitan Meat Company, is authority for the statement that he has demonstrated the practicability of the wireless system by the following telegram which he sent to Alika Dowsett, at Lanai, last Tuesday:—'Please ship by the *Golden Gate* 200 sheep; never mind about the cattle; need sheep badly.'

"Mr. Waller states that on Saturday Captain Bennett, of the *Lehua*, says when he stopped at Lanai during the week he was informed that the message had been received."

CONTRACTS OPEN AND CLOSED.

OPEN.

Amsterdam (Holland).—April 1st. The Communal Council will on this date consider tenders for the supply and erection of all the motors necessary, and the installation of the electric lighting of the power station, switchboards, &c. Conditions from the Municipal Printing Office, 10 florins (16s. 8d.). Information from the manager of the office of Electricity, Achterburgwal, 213, Amsterdam.

Aylesbury.—April 22nd. The U.D.C. wants tenders for establishing and maintaining electricity works. See "Official Notices" March 22nd.

Battersea.—April 30th. The Council wants tenders for electric pumps and pipe work, river work, pipe and pits, &c. See "Official Notices" to-day.

Bradford.—April 3rd. The Corporation wants tenders for a combined motor balancer and boosters, with switch gear for same. See "Official Notices" March 22nd.

Burnley.—April 9th. The Electricity Committee wants tenders for boilers, economisers and accumulators. See "Official Notices" to-day.

Christiania.—March 30th and April 6th. The Secretary of State for Foreign Affairs has received a despatch from his Majesty's Consul-General at Christiania stating that tenders are invited by the Norwegian State Telegraph Department, not later than noon on April 6th, 1901, for the supply of telegraph wire, bronze wire, and telephone cables. The Secretary of State has received another despatch from his Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Department, not later than noon on March 30th next, for the supply of porcelain insulators, iron angles, brackets, top coverings, top plates, and telephones. Particulars may be seen between 12 and 1, at the Technical Department of the Telegraph Office in Christiania.

Colwyn Bay.—April 13th.—The U. D. C. wants tenders for water-tube boiler, feed pump, injector, piping, &c. See "Official Notices" to-day.

Dublin.—April 22nd. The Lighting Committee wants tenders for condensing plant, pipework, feed pump, superheaters, mechanical coaling apparatus, crane, and workshop equipment. See "Official Notices" March 22nd.

Edinburgh.—April 20th. Tenders are wanted by the Corporation for arc lamp carbons and cast-iron pipes. See "Official Notices" to-day.

Farnworth.—March 29th. The U.D.C. wants tenders for electricity meters. See particulars in our "Official Notices" March 22nd.

Halifax.—April 4th and 11th. The Electricity Committee wants tenders for steam piping and trolley wire. See two "Official Notices" to-day.

Hornsey.—April 11th. The U.D.C. wants tenders for dryback boilers, pumps, economiser, 300-KW. steam dynamos, motor transformers, condensing and water cooling apparatus, pipework, switchboard, battery, crane, mains, arc lighting, meters and workshop equipment, &c. See "Official Notices" March 15th.

Kirkcaldy.—April 15th. The Corporation wants tenders for two 80-I.H.P. and three 250-I.H.P. engines and continuous current dynamos, storage battery, and 15-ton crane. See "Official Notices" March 15th.

Launceston (Tasmania).—April 22nd. The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

Leeds.—April 15th. The City Council wants tenders for steam and other piping, pumps, economisers, &c., all for engines of 4,000 I.H.P. See "Official Notices" March 15th.

Leith.—The T.C. wants tenders for a 350-KW. steam dynamo for lighting or traction. See "Official Notices" March 15th.

London.—April 24th. The Metropolitan Asylums Board invites tenders for gas producing plant and gas engines, dynamos, accumulators, and switchboard; Galloway boilers, economiser feed pumps, &c., for Tooting Bec Asylum. See "Official Notices" March 22nd.

London.—The Metropolitan Electric Supply Company announce that they are considering the expediency of adopting larger units, and are prepared to receive designs, accompanied by full specification and approximate price (erected at their works in London) for complete two-phase steam units having an output of from 3,000 to 4,000 KW. at a pressure of 500 volts per phase, and at a periodicity of 60 complete cycles per second, such units to work in parallel with the existing 1,500-KW. units of the company. As an alternative, similar units generating at 10,000 volts may be considered. See "Official Notices" March 22nd.

Madrid.—April 21st. The Secretary of State for Foreign Affairs has received a despatch from his Majesty's Ambassador in Madrid, stating that tenders are invited by the Spanish Government, not later than April 21st, for the establishment and working of a telephone system in Palencia. Particulars may be examined at the Commercial Department of the Foreign Office, between 11 a.m and 5 p.m.

Manchester.—April 8th. The Lancashire and Yorkshire Railway Company wants tenders for 12 months' supply of stores, including telegraph and electric light accessories. See "Official Notices" to-day.

Middlesbrough.—April 30th. The E.L. Committee wants tenders for a Lancashire boiler, 300-KW. steam dynamo, condensing plant, and piping. See "Official Notices" to-day.

Motherwell.—April 29th. The T.C. wants tenders for steam dynamo and switches and piping. See "Official Notices" to-day.

Partick.—April 9th. The Council wants tenders for steam and other pipes, pump, tank, feed water heater, and ironwork, &c. See "Official Notices" March 22nd.

Piatra Neamtz, Roumania.—April 23rd (new style). The mayor will on this date consider offers for the concession of supplying the town with electric light for a term of 30 years.

Portsmouth.—April 16th. The Corporation wants tenders for boilers, pumps, stokers, economisers, pipes, &c. See "Official Notices" to-day.

Roumania.—April 3rd. Tenders are again being invited until April 3rd by the municipal authorities of Ploesti, for the construction of an electric tramway in the town and the working of the same during a period of 30 years.

Roumania.—April 10th. Tenders are being invited until April 10th by the municipal authorities of Piatra Neamtz for the concession for the electric lighting of the town during a period of 30 years.

Salford.—April 9th. The Corporation wants tenders for wiring for motors, dynamo leads, engine room and switchboard connections, &c., at the Strawberry Road generating station. See "Official Notices" March 22nd.

Spain.—April 22nd. The Spanish Ministry of Posts and Telegraphs in Madrid is inviting tenders until April 22nd for the concession for the establishment and working during a period of 20 years of a telephone exchange in the town of Palencia. Particulars may be obtained from, and tenders are to be sent to, the Registro de la Direcion General de Correos y Telegrafos, Madrid.

Sunderland.—March 29th. The Corporation wants tenders for india-rubber-covered cables, stoneware casing, wrought-iron piping, and cast-iron piping, box frames and covers. See "Official Notices" March 1st.

Sunderland.—April 3rd. The T.C. wants tenders for 104 arc lamps, pillars, and accessories. See "Official Notices" March 22nd.

CLOSED.

Bradford.—The Corporation has approved tenders for the construction of a new generating station adjoining the present electricity works at a cost, for buildings only, of £21,937 10s.

Brighton.—The T.C. has accepted the tender of Messrs. Babcock & Wilcox for two additional water-tube boilers to be used in connection with the tramway generating plant for £2,150, and also for the necessary steam, feeding, and other piping in connection therewith for £643.

Dundee.—Messrs. Doulton & Co. has secured the contracts for conduits, &c., for the Gas Commissioners at £1,823.

Eastbourne.—The following tenders have been received by the Corporation for extensions of plant at the electricity works (Mr. J. K. Brydges, borough electrical engineer):—

Underground Mains.

W. T. Glover & Co. (accepted)	£7,663 13 9
Siemens Bros. & Co.	8,369 0 0
Callender's Cable & Construction Company	8,770 12 0
Western Electric Company	8,915 10 0
Callender's Cable & Construction Company (alternative)	9,580 5 4
Henley's Telegraph Works Company	10,032 17 4
St. Helens Cable Company	10,052 15 5
Electrical and General Contracting Company	11,666 0 0
Johnson & Phillips	11,673 0 0
Dennis, W. F.	11,762 0 0
Telegraph Manufacturing Company	12,070 0 0
Nussbaum, G. W.	12,796 0 0

Arc Lamp and Posts.

Gilbert Arc Lamp Company	£1,558 0 0
Crompton & Co.	1,600 0 0
Oliver & Co.	1,631 18 0
*Callender's Cable & Construction Company	1,653 15 0
Reason Manufacturing Company	1,704 0 0
Veritys, Limited	1,731 14 8
W. Lucy & Co.	1,825 15 0
Johnson & Phillips	1,907 7 0
Walsall Electrical Company	2,004 10 0
General Electric Company	2,099 0 0
Brush Electrical Engineering Company	2,275 0 0
Brockie-Pell	2,305 0 0

*Subject to receiving order for mains section. This section has not yet been decided upon.

Transformers and Chambers.

a Gilbert Arc Lamp Company	£1,599 0 0
British Electric Transformer Manufacturing Company (accepted)	3,937 0 0
c Ferranti	5,068 0 0
b Callender's Cable & Construction Company	3,624 0 0
Johnson & Phillips	4,183 0 0
Brush Electrical Engineering Company	4,768 13 6

a, Transformers only. *b*, Subject to receiving order for mains section. *c*, Exclusive of large chambers and fixing small.

London.—The Shoreditch Borough Council received the following tenders for the supply of the constructional ironwork for the new generating station in Whiston Street, the lowest being recommended for acceptance:—

Pierson & Co., London	£6,279
Cross & Cross, Walsall	6,336
Westwood & Wrights, Brierley Hill	6,496
Head, Wrightson & Co., Thornaby-on-Tees	6,811
Babcock & Wilcox, London	6,855
Crittal Manufacturing Company, Braintree, Essex	7,112
Walter Jones & Sons, Bow Bridge, E.	7,200
Mechan & Sons, Glasgow	7,740
W. A. Baker & Co., Ltd., London	8,150
Barry & Higham, Westminster	8,231
Spencer & Co., Melksham, Wilts.	9,975

Llandudno.—The National Electric Wiring Company are to carry out the wiring and fitting of the Town Hall for £482.

Glasgow.—Messrs. Babcock & Wilcox, Limited, are to supply two of their patent chain grate stokers on the boilers in the Kelvinside electric station for £240.

Poplar.—Messrs. Carrick & Sons are to supply a 5-ton electric crane to the Borough Council at £780. There were a dozen other tenderers ranging up to £1,355.

Stirling.—The T. C. has accepted the tender of Messrs. Siemens Bros. to supply a steam dynamo for £4,297.

FORTHCOMING EVENTS.

Friday, March 29th.—Electro-Harmonic Smoking Concert.

At 7.15 p.m. North-East Coast Institution of Engineers and Shipbuilders. General meeting will be held at the Marine School, South Shields. Paper to be read on "Water-tube Boilers," by Mr. Edwin Griffith, Wh. Sch.

Saturday, March 30th.—Royal Institution of Great Britain. Lord Rayleigh on "Sound and Vibrations." (Lecture VI.)

At 7.30 p.m. North-East Coast Institution of Engineers and Shipbuilders. General meeting will be held in the Institution Lecture Hall, 4, St. Nicholas' Buildings West, Newcastle-on-Tyne. Mr. A. Q. Carnegie will open a discussion on "Condensers—and the recooling of Water for Electric Power Stations."

Wednesday, April 3rd.—At 8 p.m. Institution of Junior Engineers. At Westminster Palace Hotel, fifth lecture of the course on "Works Management," by Mr. A. H. Barker, Wh.Sc., B.A., B.Sc.

Thursday, April 4th.—At 8 p.m. Civil and Mechanical Engineers' Society. Meeting at Hotel Victoria, Northumberland Avenue, S.W. Paper "On the Proportions of Cylinders for Multiple-Expansion Engines," by A. Hanssen, A.M.I.C.E.

NOTES.

To Our Readers.—As next Friday is Good Friday, we shall be glad if correspondents and other contributors will note that the Electrical Review will be published on Thursday morning. All matter for insertion in next week's issue should be in our hands a day earlier than usual.

Reduced Rates to India.—In summing up the Budget charges of India on Wednesday, the Viceroy made especial reference to the rates charged for telegrams to India. As far as we can gather, it appears that a radical change in this respect must be made to satisfy those who are concerned in Indian matters, either commercially or socially. As far as India is interested, it appears that if the present "negotiations"—whatever these may be—happen, as hap they well may, to swing back to the usual false zero, this *lâche* cannot be for one moment attributed to any slackness in Lord Curzon's intention to get to the truth of this obscure affair.

Lectures.—At the Marine Engineers' Institute, South Shields, on 18th inst., Mr. G. A. Smith opened a discussion on "Marine Electricians."

At the Society of Arts, John Street, Adelphi, on Monday, Major Philip Cardew delivered the third and last of his series of Cantor lectures on "Electric Railways."

Mr. E. H. Davies described the electric power station which has been erected at the Pierrefitte silver mines in the French Pyrenees, before the Institution of Mining and Metallurgy, in London, on 21st inst.

Appointments Vacant.—An assistant engineer and a mains foreman are required for Rotherham electricity works; an engineer-in-charge is wanted at Belfast; a mains superintendent at South Shields; and a clerk and canvasser for Bermondsey. The Hammersmith Council wants an assistant engineer, also a junior assistant in the mains department.

Personal.—We understand that Mr. C. H. Wordingham, who finally severs his connection with the Manchester Corporation electricity undertaking on the 31st inst., intends to commence practice as consulting engineer at 19, Brasenose Street, Manchester, on April 1st. Mr. Wordingham has for the last seven years officiated as city electrical engineer to Manchester, and has advised the Corporation on all electrical matters, including the preparation of the scheme for the supply of the whole area—45 square miles—and all details relating to the construction and equipment of 150 miles of tramway. We have no doubt but that Mr. Wordingham will find his hands full, and we have pleasure in expressing our cordial good wishes for his prosperity.

We learn that our esteemed contributor, Mr. E. K. Scott, has been transferred from associate-membership to membership of the I.E.E.

It may not be generally known that Mr. A. N. Connett, whose paper on "Combined Trolley and Conduit Tramway Systems," we conclude in this issue of the Review, is the chief engineer to Messrs. J. G. White & Co., Limited, electrical, mechanical and civil engineers.

Mr. Fred. Satchwell has resigned the position of manager to the Hiram S. Maxim Electrical Corporation, and has commenced business as an engineering contractor at 45, Broadway, Walham Green, S.W. We understand that he has had 21 years' experience in electrical work, principally in the equipment and management of works for the manufacture of electric incandescent lamps, &c.

The colleagues and friends of Mr. W. E. Jennings, acting assistant of the Telegraph Department in Cape Town, lately gave him a good send-off on his transfer to King William's Town. The proceedings took the form of a smoking concert, at which Mr. Jennings was presented with a handsome ebony and silver-mounted liqueur stand.

We understand that Mr. Leven has resigned his position as managing director of H. M. Salmony & Co., and has taken up the office of general manager to the Lahmeyer Electrical Company, Limited, at 109—111, New Oxford Street, London, W. We wish Mr. Leven every success in his new sphere.

The Electric Light Committee of the Coventry Corporation have voted the works' manager (Mr. G. S. Ram), who is taking up a post in London, the sum of £150 for services rendered by him additional to those expected of him under the terms of his appointment since he ceased to receive commission.

Mr. Louis J. Hunt, A.M.I.C.E., is leaving Messrs. Siemens Brothers, of Woolwich, to take up the appointment of chief electrical engineer to the Sandycroft Foundry Company, of Chester.

The Islington Borough Council has raised the salary of Mr. A. Gay, electrical engineer, from £500 to £600 per annum, and that of Mr. C. H. Yeaman, chief assistant, from £250 to £300 per annum.

Mr. A. H. Clarke, mains engineer to the Preston Electricity Supply Company, has been appointed electrical engineer to the Nederlandsch Indische Industrie En Handel Haatschappij, of Amsterdam and London, to take charge of their plant in Dutch Borneo. Mr. Clarke will sail on April 4th on the P. & O. liner *China*.

The Postmaster-General has appointed Mr. W. E. Halton to be chief superintendent of telegraphs at Manchester.

Mr. A. G. Fox, from Bermuda, has been appointed to Chatham Dockyard to take charge of the electrical works.

We are informed that Mr. S. Thos. Pemberton, at present representative engineer and electrical expert of the Blackman Ventilating Company, is transferring his services on the 1st prox. to Messrs. John Gibbs & Son, ventilating and electrical engineers, of Duke Street, Liverpool.

Bankruptcy Proceedings.—At the Paisley Sheriff Court on Wednesday, Mr. Francis Teague, late electrical engineer for the burgh, appeared for examination in bankruptcy. The trustee on the estate, Mr. G. A. Coddell, stated that he was quite satisfied with the information given by the bankrupt, and the examination was accordingly closed, and the statutory oath administered.

(*Continued on page* 549.)

THE CONSTRUCTION OF AN ELECTRIC TRAMWAY MOTOR.

By S. H. SHORT.

One of the most interesting of all the electrical machines designed for various purposes is the tramcar motor. It is required to develop a large amount of power, several times its normal capacity at times, without heating or sparking, and must use the electrical energy which it receives with a high degree of economy.

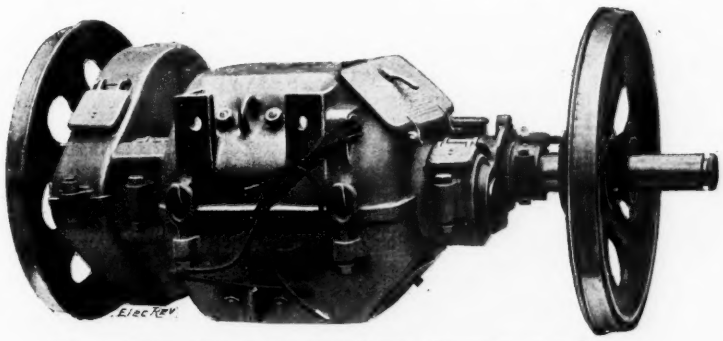


Fig. 1.—Front View of Tramway Motor, Complete, with Wheels.

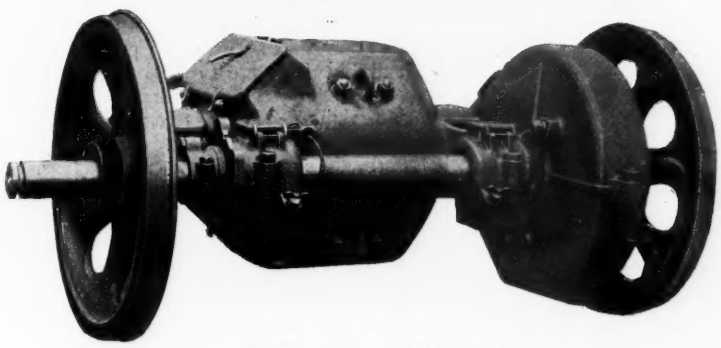


Fig. 2.—Back View of Motor, &c.

These conditions would not be difficult to fulfil if the dimensions of the machine were not restricted to the limited space available on the axle of a tramcar. No other engine, weighing but 1 ton, and entirely self-contained within the three dimensions of about 30 in., will produce from 25 to even 50 H.P. at an efficiency of nearly 90 per cent.

The smaller motors, such as are used on ordinary city trams, will develop 1 H.P. for every 80 lbs. of material entering into their construction, while the larger motors used for driving suburban and interurban trains will develop the same amount of power for every 40 lbs. of their weight.

These machines are required to perform their work under the most unfavourable conditions. Being under the car and within a few inches of the surface of the roadway, they are constantly deluged with either dust or muddy water, and must, therefore, be made perfectly water-tight.

The frequent stopping and starting usual in tramway service subjects the motors to tremendous variations of load. One moment they will be developing twice their normal capacity, and the next the load will be entirely off.

The machine is simplicity itself, but is made with the greatest care. Its parts must be so well designed, the material for each so well adapted to the purpose, and the lubrication so perfect, that the motor will run continuously without attention, except the replacing of worn parts.

Many years of experience and large sums of money have been spent in the development of the modern tramcar motor, the history of which is exceedingly interesting in showing how, one after another, the apparently insurmountable difficulties have been overcome, until now we have a most reliable and economical machine for carrying on the traffic of our cities.

We propose to describe and illustrate the various processes through which the steel, iron, and copper must go to make a complete modern motor.

For this purpose we have selected the standard motor which is being supplied to various Corporation tramways in England and to many of the Colonial cities by Messrs. Dick, Kerr & Co. This motor is known as "No. 25, Type A," built by the English Electric Manufacturing Company.

The adjoining illustrations, figs. 1 and 2, are the front and rear views of the complete motor, with its axle and pair of wheels, ready to be mounted in a truck preparatory to placing it under the car. They show the general form of the machine, the lugs from which it is supported by the cross suspension bar of the truck, the axle bearings, and gear housing.

The motor is designed for a minimum track gauge of 48 in., and it will deliver 25 H.P. at the armature shaft based upon the standard rating, *i.e.*, a rise of temperature of not more than 75° C. in its various parts after running for one hour at full load, the temperature of the surrounding air not exceeding 25° C.

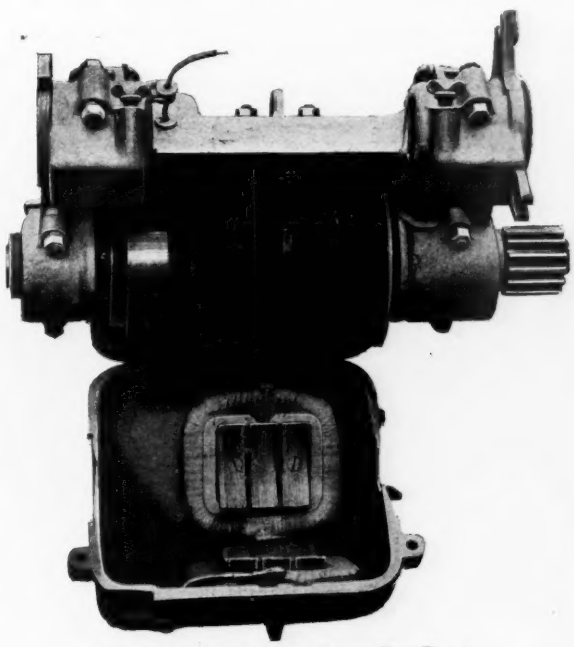


Fig. 3.—Lower half of Frame Let Down.

When mounted on 30-in. wheels with a gear ratio of 5 to 1, the motor will drive the car at a speed of 10 miles per

hour when working at full load. The lower half of the motor is hinged to the upper frame, and can be let down

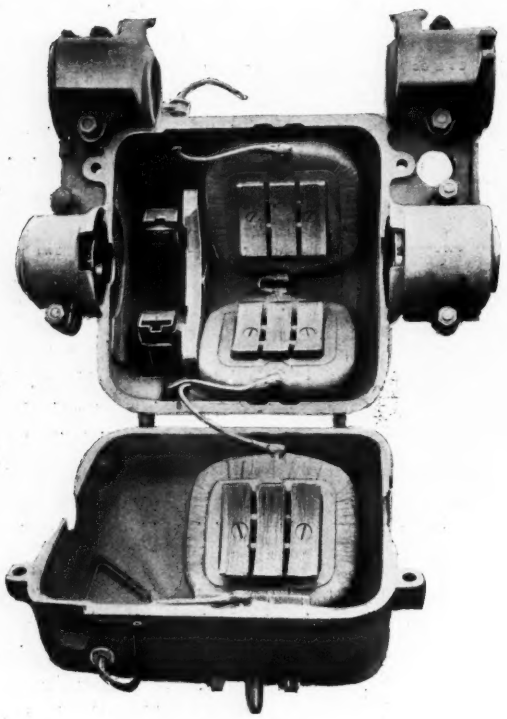


Fig. 4.—Frame Open, Armature Removed.

(fig. 3), thus exposing the armature and the lower fields for inspection, cleaning and repair. The armature may be removed from the motor by loosening the four bolts which secure the bearing caps, when the whole of the interior of the frame together with the brush holders can be reached (fig. 4). The lower half of the motor frame may be unhinged from the upper half (fig. 5).

Motor Frame.

From the illustrations of the assembled machine it will be seen that the motor frame is made in the form of two bowl-shaped castings of soft steel. The magnetic conductivity of these parts must be good in order that the castings may have as little weight as possible. The two halves of the frame are fitted together with a carefully machined joint, to secure a low resistance path for the magnetic lines, as well as a water-tight joint. The frame, therefore, serves the triple purpose of forming the yoke of the multipolar field magnet, providing a complete shell covering the working parts, and supporting the armature and axle bearings. To the upper half of the frame are cast the bearing supports for the axle and armature shaft. An opening is made in the frame just over the commutator for the purpose of reaching the brushes, and is provided with a malleable iron lid which fastens securely.

Pole-Pieces.

The inner periphery of the frame is provided with four equally spaced rectangular surfaces, finished true with the centre of the armature shaft. To these surfaces are bolted four laminated pole-pieces, around which the exciting coils of the field magnets are wound.

Fig. 6 illustrates the process of manufacturing these pole-pieces. They are made from sheet-steel punchings, the steel being of good quality, low in carbon, with high magnetic permeability. Enough of these punchings are rivetted together to make the section required in the magnetic circuit.

Two ventilating spaces are left in the pole-pieces, which allow the air to escape from the armature ventilating ducts and come in contact with the cool surface of the outer shell. The punchings are provided with projections or pole-horns next to the armature core. These pole-tips, although apparently insignificant, are important, for they distribute the magnetic field in such a way as to produce sparkless commutation, and likewise serve to hold the field coils in position.

For the sake of high efficiency it is best to laminate the pole-pieces, for with solid castings eddy currents are set up in the pole faces by the armature teeth and windings. The four pole-pieces are alike and interchangeable, and all of them are provided with field magnet coils. This ensures the perfectly even distribution of the lines of force in the multipolar field magnet necessary to good performance at the

Fig. 5.—Component Parts of Motor Frame.

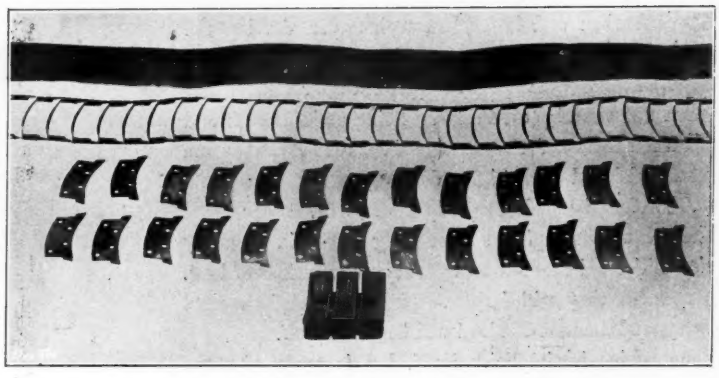


Fig. 6.—Process of Constructing Laminated Pole-piece.

commutator. In fact, any lack of symmetry in the design of a tramcar motor results in unsatisfactory performance of some kind. By making all the parts similar, the supply of spare parts kept on hand for repairs is greatly diminished.

Field Coils.

In the construction of the field coils (fig. 7) the best quality of copper wire, insulated with asbestos paper and cotton covering, is used. The coils are machine-wound upon a former of the same shape as the pole-pieces over which they are to be fitted. After removing them from the former they are immersed in an insulating compound, which fills the spaces between the wires. They are then thoroughly dried, and a thick covering of combination mica, paper and cloth insulation is applied to the outer surface of the coil, which is finally taped with strong braided webbing.

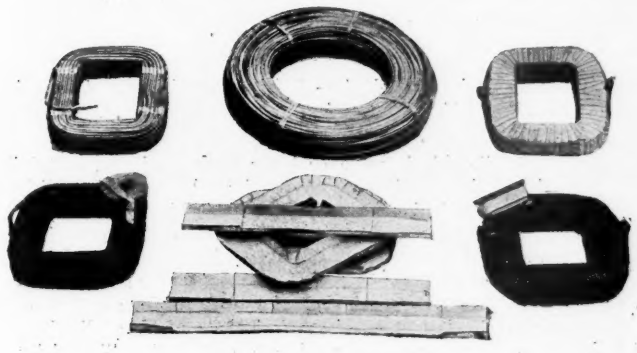


Fig. 7.—Construction of the Field Coils.

The complete coil is waterproofed with a compound which renders it impervious to moisture. The ends of the wire terminate in bronze castings, which are easily connected together after the coils are assembled in the motor frame. In order that the magnet coil shall be secured in the motor frame so firmly that no movement can take place, a rectangular bronze frame is forced into the interior of the coil, through which the pole-pieces are passed to be bolted in their places on the inner surface of the motor frame. A perfect magnetic joint must be secured between the pole-pieces and the motor frame, and the pole-horns must draw the coil tightly against the inner surface of the shell.

(To be continued.)

MESSRS. NALDER BROS. AND THOMPSON'S DALSTON WORKS.

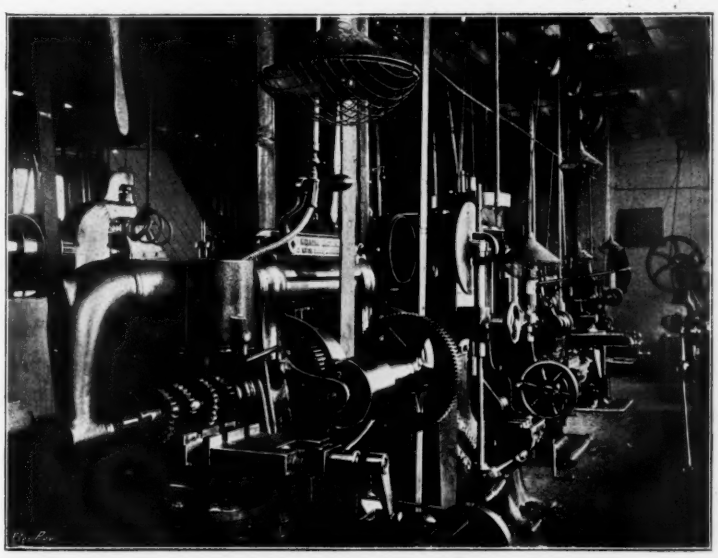
We recently paid a visit to the works of this company, who, owing to the rapid progress of their business, had to establish works at Kingsland Green, Dalston, in addition to the factory at 34, Queen Street. These works are devoted to the manufacture of the parts of instruments and complete switchboards and circuit breakers. The assembling and testing of instruments are still carried on at Queen Street as formerly.

The ground floor of the works, at the entrance of which we noticed a Rochester time recorder, is mainly devoted to stores and time-keeping departments, engine room and dynamo room, the dynamo being provided for the purpose of lighting the works as well as for providing current for motors, instead of relying on long belting transmissions for the upper floors. In addition to these are the painting shop and lacquering shop, both of which have the very best lighting, and in this respect we must say the whole of the works is exceptionally well off. In the erecting shop on the ground floor, for the larger class of switchboards, was a portion of the Luton central station board, which may be seen in one of our illustrations. This erecting shop is fitted with the most modern tools for drilling slate and for dealing with large bus bars, a number of which, for another important station board, were in preparation.

On the first floor the machine shop proper is situated. We give a view of the west side, which is devoted almost entirely to milling machines. On the east side, of which also a view is given, the turret and engine lathes are situated. The drilling machines are placed in the middle of the shop, and, as far as possible, all machines of a kind are grouped together.

The suds and oil for the whole of the machinery on this floor are supplied to each individual machine from a tank situated at the top of the building, all the lubricant running from the machines into open troughs placed below the floor, whence it runs into another tank, out of which it is continually pumped to the upper tank already referred to. Nearly the whole of the work carried out on this floor is done systematically to special jigs and fixtures. We noticed, in passing, that many of the tools here were of American make, and the system of keeping the shop in a cleanly condition, as well as the heating by suspended steam pipes, was in accordance with the practice now more generally obtaining. At the far end of the shop a tool room is situated. In this shop not only are the tools stored for serving out, but all operations for fitting in connection with them are carried through here. In addition to the lathes for special work in this shop, a gas furnace is provided for hardening and tempering the more delicate tools. The blower which serves this also furnishes compressed air to the various blow-pipes throughout the building.

Adjacent to the tool room is the grinding room, which is provided with Brown & Sharpe's universal grinding machine,



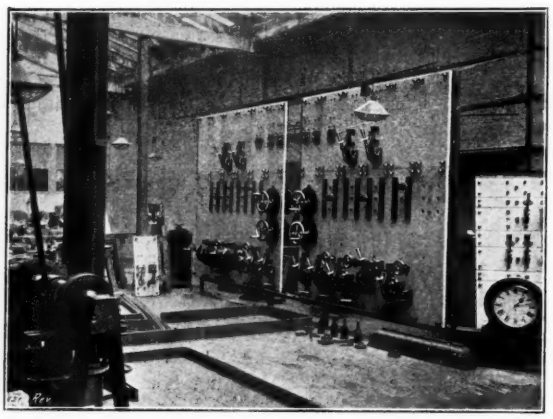
Machine Shop.—West Side.

surface grinding machine, Cincinnatti universal cutter grinder, and a Washburn twist drill grinding machine.

On the second floor the assembling of switches and circuit breakers and small parts is generally carried out. This is provided with numerous lathes and drilling machines in the body of the shop, and also an engraving machine. All round are arranged benches with vices. In addition, on this floor all finished work is taken into stock.

The third floor is also devoted to fitting and assembling work, and large switchboards are erected here, as there is plenty of head room and splendid light. This is more

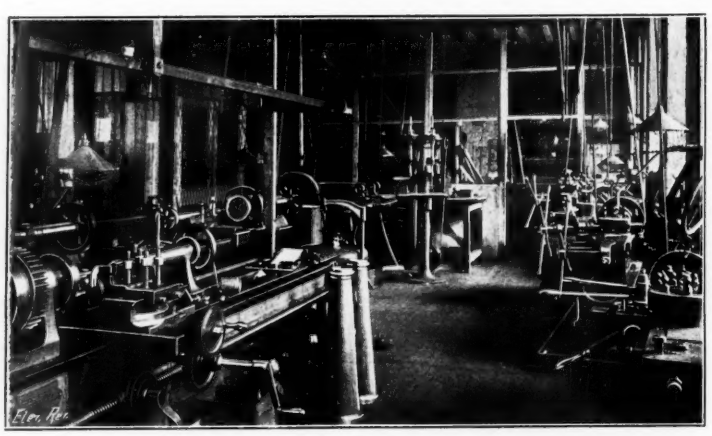
easily accomplished, insomuch that in the middle of the building a power-operated elevator is provided which passes



Messrs. Nalder's Dalston Works.—Erecting Shop.

from the bottom of the building to the top. Ample bench and vice accommodation is also provided up here.

At the time of our visit to the shops we saw a considerable amount of heavy switchwork in hand, and quantities of parts going through for general stock.



Messrs. Nalder's Dalston Works.—Machine Shop.—East Side.

REVIEWS.

Journal of the Institution of Electrical Engineers. No. 148.

This number contains Mr. Langdon's paper on "The Supersession of the Steam by the Electric Locomotive," with the discussions thereon in London, Newcastle and Glasgow; Mr. Duddell's paper on "Rapid Variations in the Current through the Direct Current Arc," discussed in London only; Lieut.-Col. Crompton's lecture on the Electrical Engineers (R.E.) in South Africa; and Mr. Earle's paper on the "Relative Advantages of Direct Current and Three-Phase Distribution for Small Installations," as well as a communication by Mr. Russell on "The Regulation of the Potentials to Earth of Direct Current Mains."

The A B C of Dynamo Design. By A. H. Avery. London: Dawbarn & Ward, Limited.

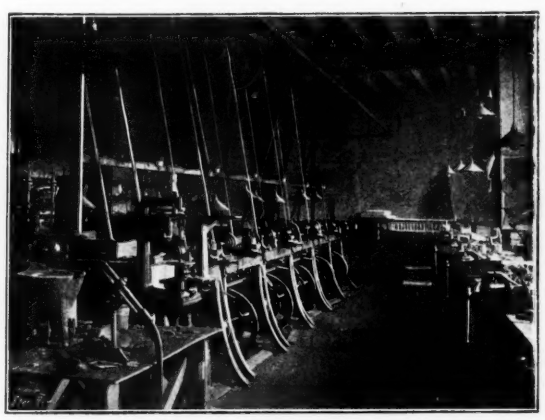
This is a reprint of a series of articles which appeared in the *Model Engineer*, and is intended to guide the amateur dynamo-builder on a rational basis. For this purpose the elementary principles of dynamo-electric machinery are first briefly explained, but, we regret to say, not always correctly. For instance, on p. 12 it is stated that uniform motion of a conductor in a uniform field cannot produce electromotive force; this is nonsense. The same error recurs on p. 19. On p. 20 it is stated that the E.M.F. generated in a conductor on the surface of a drum armature in a two-pole field varies as the sine of the angle of rotation; this is by no means true if the armature core is as usual of iron. The diagrams on p. 24, showing the fluctuations of E.M.F. as affected by the number of commutator segments, are also quite wrong for a closed-coil armature. On p. 75 the back ampere-turns are given a value half as great as the true value, and the error is accentuated in a footnote by halving this again.

On the whole, however, remembering the object of the book, we must say that it is well written and gives fairly clear instuctions to design and build dynamos for 30, 500 and 2,000 watts output. The drawings are neat, and dimensions are supplied in the text, while the author's strong disapproval of the shuttle, three-pole, and other mis-shapen armatures, once so popular with amateurs, and his adoption of a thoroughly practical and up-to-date type of armature and field magnet, are bound to receive our hearty endorsement. We have no doubt that amateur electricians will find the book both interesting and useful.

Handbook on Electro-Plating, Polishing, Lacquering, Burnishing, Enamelling. Birmingham: W. Canning and Co. 1901.

While this is more or less a trade catalogue, containing descriptions of the apparatus and methods of the publishers, it is none the less a thoroughly practical book of reference for manufacturers and others who have occasion to include electro-plating amongst their working processes. The size and arrangement of the plant required for a given output, based on the practice of the cycle trade, are first dealt with clearly and concisely, and the methods of distributing the heavy currents used are explained. Electricity is strongly recommended as the motive power for the dynamo and polishing lathes, its advantages being pre-eminent and obvious; lucid instructions are given for the care of dynamos and motors. Then follow full directions as to the management of the baths for electro-plating articles with nickel, brass, copper, silver and gold. Tin-plating is also described, and electro-typing with copper. The remainder of the book deals with scratch-brushing and sand-blasting, and the materials and machines used in polishing, burnishing, lacquering and enamelling. A small section on primary and secondary batteries is included, but the use of the former is deprecated, except for the smallest and most casual work.

The book teems with practical hints and suggestions, and



Messrs. Nalder's Dalston Works.
Assembling Shop for Switches and Circuit Breakers.

will, we feel sure, go a long way to meet the requirements of those engaged in the processes described. The style in which it is written is, unfortunately, slipshod, and the use

of electrical terms not all that we could wish; we trust that these defects will be remedied in future editions.

The Engineers' Year Book, 1901. By H. R. Kempe. London: Crosby Lockwood & Co. 1901.

This annual has now reached its eighth year of publication, and has attained to nearly 800 pages, despite the continuous elimination of the less desirable or out-of-date matter. Additions have been made to various sections, including that on Machine Tools, Workshops, Steam Boilers, Electric Traction, Mechanical Stoking, Air Pumps, Motor Cars, Water Softening. We should like to see the ring main steam pipe arrangement eliminated. This ought to be unnecessary, for steam pipes would be exposed to less danger from within if not in ring form, and should be good enough to stand by themselves. If they must be in any sense double, we would rather see two lengths of half area, so that one length may serve should the other half fail. We note an illustration of the Edwards air pump, which is an adaptation or modification of an old idea carried out in a novel and ingenious manner. Aluminium obtains practical recognition as a material for construction, in the way of tables of weight of the metal in sheet, bars, or pipes.

It would be merely repeating what we have said in past years to do more than draw attention to the mathematical tables, the rules of the Board of Trade and Bureau Veritas and Lloyd's, the sections on locomotives, steam engineering, rope gears, cold storage, properties of materials, and a thousand other subjects condensed into the volume. There are, of course, still omissions to be filled up, and we may hope to see the section on Belleville boilers eliminated, if, as we hope, that boiler soon becomes of historical interest only. The Year-book well maintains the quality and quantity of its contents, and is one of the most complete engineers' books of reference now extant, while its yearly revision renders it particularly reliable, old matter being deleted or corrected to date and new matter added as new processes become grafted into regular practice and improvements are made.

NOTES.

(*Continued from page* 544.)

Steel.—The air and the press are filled with rumours as to what is being planned by steel manufacturers in this country and on the Continent in order to combat any evil influence that the American Steel Trust may have in this part of the world. According to one statement, British steel manufacturers have been negotiating with a view to combination, and the mutual operation of several of the largest establishments is stated to be practically settled. In many quarters expression is given to the view that the American Trust may prove to be a blessing in disguise to the British steel trade by awakening its leaders to a full appreciation of their position. On the Continent there are statements issued regarding a Franco-Italian steel trust, of which M. Schneider is the organiser. Although not to be regarded in any way as a counterblast to the American Trust, Mr. Sheriff Lawrence's Edison Ore Milling Syndicate, about which the London press has published much during the past week, is of interest in this connection. The syndicate, we understand from Mr. Lawrence's statement, has acquired extensive iron ore deposits in Norway, upon which it proposes to employ Mr. Edison's new magnetic processes for the crushing and separation of low-grade iron ores. Edison's process has been experimented with for some years at great cost. The syndicate, after sending a commission out to Edison to investigate, came to the conclusion that if one-half of his claims were realisable, the results would mean an industrial revolution on an extensive scale. Experimental research and investigation of the practicability of the process mechanically and commercially, have brought about results which lead Mr. Lawrence to state that, "We are now enabled to take two tons of this low-grade non-Bessemer ore, and by the combined Edison processes produce from it over one ton of high-grade Bessemer ore, averaging 65 per cent. of metallic iron." The syndicate has acquired Norwegian property which contains at least 80 million tons of ore, and it is its intention to erect works, and ship it exclusively to British iron masters, there being already a market for it at a superior price. The property is situated at Dunderland in Northern Norway, and as there is an abundance of water-power, electrical transmission will be employed for driving the crushing plant and conveying the ore.

The first 2,000 tons of American rails for the Great Eastern Railway have been delivered.

Glasgow International Exhibition.—Our local correspondent writing on March 20th, says:—"I paid a visit to the grounds to-day. The Art Section is practically complete, and is lit throughout by electric light. The Grand Hall of the Art Galleries is lit by a series of most elaborately-finished electroliers of massive appearance and of polished brass. The side galleries are lit by means of arc lamps, and the smaller courts by clusters or spider fittings of polished brass. The wiring of this building, which will form a permanent art gallery and museum after the Exhibition closes, is fireproof throughout; steel tubing is used for the protection of the wires. The Schuckert Company have now some 20 motors and dynamos in the Machinery Hall. The electric lighting system is practically finished, some 900 arc lamps being in position. The various foreign sections are now completing their displays, notably the French and Russian, the former showing motor-driven machinery."

It is now officially stated that the opening is to take place on May 2nd. The Press view will be on April 24th. The two 1,200-H.P. Willans & Robinson engines, and the Alley and McLellan sets are now in place, while the remainder of the generating plant is rapidly finishing.

American Electrical Contractors' Association.—About 18 months ago a number of electrical contractors of New York State formed themselves into an United Electrical Contractors' Association, with the object in view of protecting their respective interests and promoting a more cordial feeling in the contracting trade. This Association, which took in the larger contractors in all the cities of New York State, has proved to be of such a great benefit to members that a movement is now on foot to form a National Electrical Contractors' Association. A meeting will be held at Buffalo in July for the purpose of carrying the thing through.

The Electro-Harmonic Society.—As we announced in our last issue, the final smoking concert of the season 1900—1901 takes place this evening. The programme can be seen in our business columns, and looks attractive enough to draw together a goodly muster of members and their friends. Mr. J. E. Kingsbury, of the Western Electric Company, has, with his usual amiability, consented to take the chair.

Electrical Engineers Volunteers.—We understand that the company of Electrical Engineers Volunteers, which had expected to leave London for South Africa on Wednesday last week, was ordered to go from Euston to Liverpool on Monday to embark on the *Bavarian*.

Royal Society.—The following papers were down for reading yesterday, Thursday:—

Sir N. Lockyer, F.R.S., and F. E. Baxandall, "On the Arc Spectrum of Vanadium." Prof. E. Wilson, "The Growth of Magnetism in Iron under Alternating Magnetic Force." Dr. H. A. Wilson, "On the Electrical Conductivity of Air and Salt Vapours."

Presentation.—On Saturday last Mr. G. S. Ram, city electrical engineer, Coventry, was presented by the staff of the Corporation electricity works with a handsome spirit and cigar cabinet on the occasion of his leaving the works for London.

Standardising Bureau.—The United States Congress has just passed a Bill to establish a National Bureau of Standards. The Bill appropriated $100,000 towards providing a suitable building, the entire cost of which must not exceed $250,000. It is to be erected in the district of Columbia, probably in some suburban neighbourhood where it will be possible to escape earth tremors and the influence of heavy electric currents in the vicinity, and, says the New York *Electrical Review*, its construction is to be begun at once. Our contemporary hopes that within a few years the institution will enjoy the same reputation that is now possessed by the German Reichsanstalt. "It cannot fail to exert an immediate and directly beneficial influence on American elcctrical manufactures."

M. Bullier and Calcium Carbide.—Readers interested in calcium carbide will remember that in 1894 and 1895 M. Bullier, of Paris, took out patents in England, France and Germany for a method of preparing carbide in the electric furnace, which patents appeared for a time to give him an absolute monopoly in this substance on the Continent. The German Bullier patent, however, was annulled at the close of 1898, and since that date there have been no restrictions upon the manufacture within the limits of the Empire, except those derived from minor patents which protect special types of electric plant. Last summer, M. Bullier's French company, "La Société des Carbures Métalliques," brought an action for infringement against two rival concerns in the Civil Tribunal of the Seine, and on July 13th the plaintiffs obtained a verdict with costs but without damages. The decision was appealed against, and last month the French Court of Appeal upheld the verdict in favour of M. Bullier's patents. A further appeal to the Cour de Cassation is still possible; but at the moment of writing we do not know whether the original defendants intend to carry the matter further on the same issue. Nevertheless, the identical point is to be raised in a different way. We are informed that several French manufacturers of carbide, who are not working under license or in agreement with M. Bullier, have united for the purpose of bringing an action to have the Bullier patents declared invalid, and we believe the preliminary steps to that end have already been taken. M. Bullier's French patent seems to claim the manufacture of "crystalline" carbide, and it has been suggested that possibly this adjective may indicate a way out of the monopoly, even if the patent is finally held to be good. It is almost impossible to appreciate thoroughly the rights of a foreign commercial dispute, but it is difficult to see exactly what M. Bullier has himself invented or discovered; and it would be very interesting to know what relationship there is, if any, between MM. Bullier and Moissan in these French proceedings. Most people think that Bullier was only Moissan's assistant when the latter carried out his classical researches on the electric furnace and the scientific aspect of calcium carbide manufacture. We have no clear evidence that Bullier has ever done much original work in this direction. M. Bullier also claims a monopoly in the manufacture of the single and twin semi-atmospheric burners (on the "Naphey" principle) which are used so largely for consuming acetylene, basing his claim on one main and two subsidiary French patents dating from April 20th, 1895, to June 12th, 1896. His first patent certainly appears to have been of a purely theoretical character, and it in no way describes the burners of the present day; one of the minor patents apparently does cover them, but we understand that by French law if the first patent is bad, the others fall automatically. Moreover, it is asserted that true Bullier burners were not placed on the markets till long after German jets of identical construction were being freely imported, when suddenly last summer several dealers were "raided," and their stocks of alleged contraband goods confiscated. Some of these firms have acknowledged the justice of M. Bullier's proceedings, but others have declined to do so, and accordingly this matter is also in the Courts. An action was brought last January for infringement against a firm of dealers in Paris, and the case was argued at length; now the technical question has been referred to a committee of three experts, whose decision is still unknown. One of the reasons why our neighbours are so excited about this burner patent, we gather, is because M. Bullier's jets are stated to be made in Germany; and the rivalry between the two countries in all matters connected with carbide and acetylene is very acute, the French laying claim to scientific and commercial priority in exploiting the product of the electric furnace. M. Bullier holds a carbide patent in this country, No. 2,820, February 8th, 1895. To the non-legal mind, however, it seems identical with the Willson patents, Nos. 16,342, August 27th, and 16,705, September 1st, 1894, and we may assume that the forthcoming actions between the Acetylene Illuminating Company, the Giffre Carbide Company, and the United Alkali Company will be fought on the Willson patents. Still, if the Bullier patents are ultimately rejected in France, as they have been in Germany, it may very possibly be more difficult to sustain the analogous Willson patents in the United Kingdom.

The Pan-American Exposition.—The Pan-American Exposition will open promptly on May 1st, and the plans for that important day and its features are now being discussed by the Exposition management. As President McKinley and his cabinet officers will be on a train speeding with all rapidity toward the Pacific coast to keep an engagement made months ago, it will be impossible for them to be in Buffalo on that day. However, it has been decided, and is now being arranged, that President McKinley shall take part in the exercises of the opening day, for his train will be connected by telegraph with electrical apparatus in the Music Temple, and this apparatus will be in turn connected with the great electric apparatus in the Electricity Building. At the same moment direct telegraphic communication will be made with the executive offices of the presidents of all the Republics of the Hemisphere, and the Governor-General of Canada, and this electrical apparatus in the Music Temple. At exactly 2 o'clock, Buffalo time, the presidents and rulers of all the countries of the Western Hemisphere will be requested to touch an electric button in their offices which will thus start a piece of electrical machinery in the Exposition. At the same time they will transmit a message of greeting to be read to the assembled multitude in Music Hall. By means of a special telegraphic apparatus on his car, President McKinley will start the great fountain pumps, and will transmit over the wires a message of greeting to the people assembled. The details of this remarkable arrangement are now being worked out. Appropriate services will be held in Music Temple at the hour indicated. The imposing dedicatory ceremonies of the Exposition will take place on or about May 14th or 15th, when it is expected that Vice-President Roosevelt, Governor Odell, and a large body of national and diplomatic officials, and those of the Army and Navy will be present. Present expectations are that President's Day will be somewhere about June 9th to June 12th, at which time President McKinley, his cabinet and ladies, will reach the Exposition from the west.

Tale of an American Dog.—The following is American. It was sent to the New York *Evening Post* by a correspondent:—"A black cocker spaniel of my acquaintance has hit upon a pleasure so novel in canine society, that it deserves recording. A young lady of the family to which he belongs once tested him by scuffling about the rugs of her home until she could give an electric spark of considerable snap, and then discharging it upon the nose of her pet, the spaniel. Not long after this abuse the dog was observed to roll upon the rugs, entirely of his own accord, and then to run to the brass bedsteads and obtain a spark. This he continues to do, and his own observations seem to have taught him that he must approach metal in order to receive the spark. In one room he runs to the bedstead; in another to the register, and as he licks his nose after the pricking of the spark, he never fails to wag the remains of his tail, and his face assumes a decided expression of pleasure."

Street Railways and Electrolysis.—Our New York namesake says that a short time ago a Bill was introduced in the State Legislature of Indiana for the prevention of electrolysis. "By the terms of the Bill every street railway company which uses the overhead trolley system or any other system employing an insulated or grounded return of feed circuit must instal the double-trolley system, or its equivalent, according to the approval of the Board of Public Works, or on approval of the councils in cities where they do not have such boards. If, within two months of the date upon which the Bill goes into effect, any company has failed to submit plans, or fails to carry out the plans six months after their approval, it shall be liable to a fine of $25 per day. Upon failing to pay this penalty, the road shall forfeit its charter. Grounding, or connection with the earth, or grounded traction wires conveying an electrical current for electrical lighting, power and heat, are also included in this Bill and met by the law."

Smoke in Lambeth.—It may be remembered that a short time ago the South London Electric Supply Corporation was fined at the Lambeth Police Court the sum of £10 in each of 10 cases of alleged black smoke nuisance. At the time Mr. Hopkins, the magistrate, was asked to state a case for the superior court on the ground that there was no positive evidence of nuisance given by the witnesses, and that it was not sufficient under the section of the Act to merely show that black smoke issued from the chimney for any length of time unless it was also proved that such smoke was a nuisance to the neighbourhood, which none of the witnesses proved on that occasion. We now understand that the magistrate has stated a case, and the company has set it down for argument. On its part the Lambeth Borough Council has instructed the clerk to support the magistrate's decision before the Court of King's Bench.

The Welsbach Incandescent Electric Lamp.—The *Gas World* says that:—"Dr. Auer von Welsbach's new osmium incandescent electric lamp is said to consume, as now made, 1½ watts per Hefner, that is, 1·71 watts per English standard candle, and to last from 700 to 1,200 hours. A specimen used 1·65 watts per standard candle at first, and 1·94 watts after 1,500 hours, at which period it was intact. The lamps can be readily repaired if the filament be not broken. The voltage required is only from 25 to 50, instead of 100 to 220 volts. At a demonstration given to the shareholders of the German Welsbach Company recently, four of the new lamps, in series, consumed 0·96 ampere at 100 volts, while four carbon lamps at 100 volts took 2·40 amperes. Other experiments showed economy of current amounting to from 60 to 65 per cent. The low voltage seems to present certain difficulties in connection with domestic fittings, but none in establishments sufficiently large to enable several lamps to be put in series."

The Briton and his Commercial Rivals.—The letter by Mr. G. J. S. Broomhall, which appears in our "Correspondence" columns this week, and which has also gone the round of the daily press, contains some peculiar reasoning. How on earth does the writer arrive at the conclusion that by combining the *per capita* exports of Germany and the United States the result is as he gives it. The final column is per two people not *per capita!* Mr. J. Holt Schooling, in a communication to yesterday's *Standard*, completely demolishes Mr. Broomhall's arguments, which he characterises as absolutely without value, and he is ably seconded by Mr. Ralph Neville, but curiously enough, neither of these gentlemen seem to have observed the inexcusable and extraordinary blunder to which we call attention; Mr. Schooling, indeed, going so far as to say that the figures "are correct in themselves," although he proves Mr. Broomhall's deductions to be both fallacious and erroneous. Our electrical and mechanical engineers, Mr. Broomhall to the contrary notwithstanding, are only too well aware that American and German competition is real and not imaginary.

CITY NOTES.

Hove Electric Lighting Company.

The annual meeting, held at the Cannon Street Hotel on Monday, was presided over by Colonel Filgate, who, in moving the adoption of the report, said that the capital outlay during the year amounted to £6,862 and the total expenditure up to the end of the year £100,523. He told them last year that they had increased the generating station at Hove to the full extent allowed by the Corporation of Hove, and last year they added another Crompton-Willans set of 250 H.P. at a cost of £2,385, and they could get no more engine-power into the station. This increased the generating plant to 1,940 H.P. They had increased the length of mains during the year by 1,680 yards, and had expended £3,194 on strengthening mains and feeders. They had ordered another Babcock & Wilcox boiler for erection this summer, and, with this addition, hoped to be able to meet the demand during the ensuing winter. They had now matured their plans for their new station. That station was so designed that it could be enlarged to meet requirements for a number of years. While the year 1898 showed an increase of 82,000 units delivered to customers over 1897, 1899 shows an increase of 94,000 units delivered over 1898, and 1900 95,000 units over 1899. Last year they agreed to supply customers on the 220-volt pressure at 7d. per unit for the first hour instead of 8d., and this had led to a good number of customers changing over from 110 volts. The Corporation of Hove have steadily opposed such change over, and had apparently done a good deal to prevent customers changing to the higher voltage; indeed, recently they have refused to allow any such change, although more than four years ago they authorised the company to take on future consumers at 220 volts. To meet capital outlay last year they issued 1,000 new £5 shares at a price of £7 10s., which were at once taken up by the shareholders. The premium on these shares, amounting to £2,500, had been placed to the credit of the reserve fund, and they could not say yet what further capital they would need this year. In addition to paying for the new site and a considerable expenditure on the new station, they would have to pay for the additional boiler for the old station, and to spend no small sum on strengthening existing mains and constructing additional mains. The form in which the capital was to be issued will depend on the condition of the market when the issue is necessary. The number of houses on the system has increased from 671 at the end of 1899 to 802 on December 31st, 1900. At the close of the year the lamps and motors connected reached 52,919 8-C.P. lamps, against 44,824 at the end of the previous year, and the units sold to customers during the year amounted to 539,208, compared with 444,499 sold in 1899. The gross revenue of the year 1900 was £13,841, compared with £12,070 realised in 1899, an increase of £1,771. The increase would have been considerably larger but for the reduction made to consumers on the 220 volts and a reduction in meter rents. The expenditure amounted to £6,125, against £4,973 in 1899, an increase of £1,152. The greater portion of this increase was under coal, due to the rise in price and larger consumption. The result of working the undertaking during the year was a net revenue of £7,715, compared with £7,097 in 1899. Considering the rise in the price of coal, and that the gross revenue for current only amounted to 5s. 4d. per 8-C.P lamp, the result was most satisfactory. The units delivered to customers during the first 10 weeks for the last two years and the present year have been as under:—1899, 111,722; 1900, 139,007 (increase of 27,235); 1901, 164,180 (increase of 25,173).

Colonel Wood seconded the motion, which was adopted, as were also resolutions declaring dividend and re-electing director and auditors. A motion to increase the directors' remuneration by £200 was proposed, but on account of the small attendance of shareholders was deferred until the next meeting.

Oldham, Ashton and Hyde Electric Tramway Co.

The fourth ordinary general meeting of the shareholders of this company was held on Thursday, March 21st, at the Cannon Street Hotel, Mr. E. Garcke, M.I.C.E., presiding.

In moving the adoption of the report, the Chairman said it was a satisfaction to the directors to state that notwithstanding two or three adverse circumstances which had occurred during the past year, the results of the company's working had been very satisfactory. The net balance standing to profit and loss account enabled the directors to pay the charges in respect of the debenture and the cumulative preference dividends, to put the sum of £1,000 to the depreciation fund, to pay a dividend on the ordinary shares at the rate of 6 per cent., and to carry forward £177 to the next account. He did not think that an examination of the accounts would show that the directors had done unwisely in making the recommendations that they had with respect to the disposal of the available balance. Taking the view that the whole of the up-keep of the plant and rolling stock and permanent way had been paid for out of revenue, they might have put a smaller amount to depreciation; but as he had explained on a former occasion, it was exceedingly desirable not only to keep the whole of the undertaking in a high state of efficiency, but also to provide for the expiring tenure of their undertaking, and for the possible replacement of permanent-way or rolling stock at some

distant date. That could only be done by setting aside each year a portion of the profit earned. It was not wise or prudent to leave those necessities to take care of themselves when they arose, and it was only by accumulating the fund which they propose to invest separately outside the business that they could feel secure in regard to the future. Turning to the accounts they would see that the undertaking had developed satisfactorily, and that the traffic receipts, although proportionately less than the previous half-year, owing to the strike, had been fully up to the average. The whole of the expenses with the exception of one item had been about on a level with the previous year. The item which showed an increase was that of administration and general expenses, which stood for the past year at £2,518, against £1,057. That was due to various items of expenditure which had occurred for the first time. They had had to pay over £100 for income-tax. A new item altogether was that of debenture trustees' fees, £120, and, of course, the item for strike expenses was an exceptional one. The further expenditure on capital during the year for new cars, &c., had amounted to £6,219. With regard to the strike of their motor men and conductors, the shareholders had been informed by special circulars as to the cause of the strike, and the action the board took. They did not know what the real grievances of the men were, and they had taken every step in their power to prevent them going out on strike, but without avail. The simple fact was that the Trade Union of the district felt it incumbent upon them to assert their authority, and to come into evidence, and as their superintendent had taken sundry measures of a perfectly justifiable kind to prevent interference with their men by the Union officials, they took the view that the company was making an attack upon them, and so without real grievance on the part of the men, they ordered a strike. The strike continued for five or six weeks, and during that time they were bound to maintain the service, which they did in a thoroughly efficient manner, but the Union officials instituted such a thorough boycott that very few people cared to travel by the cars, and the result was that their receipts were very small indeed. After five or six weeks the men came back to work, and the directors reduced the number of men as they originally proposed doing, and there was no further opposition on the part of the trade union, so that the principle from which the directors thought it necessary to fight was accomplished, and there was absolutely no reason why it should not have been accomplished without the strike. After referring to the litigation that the company had embarked in against the Hyde Corporation, and in which they had been unsuccessful, the chairman said that as the shareholders would know, the light railways order which they had promoted for the extension of their line was rejected by Parliament. Unfortunately, the very success of the business raised not only the admiration, but the envy of the local authorities, and they opposed the extensions, and were now seeking similar powers themselves. The directors would oppose that application on the ground of competition. In conclusion, the chairman said that the board were asking power to increase the nominal capital of the company by £20,000 by creating 10,000 new preference shares, and 10,000 new ordinary shares. It was the intention to offer them to the shareholders in proportion to their present holdings. The price at which they were to be issued had not yet been decided, but it would be such as to let the ordinary shareholders have a substantial advantage over the present market price of the shares.

Mr. Atherley Jones, K.C., M.P., seconded the resolution which, after some discussion, was agreed to.

Subsequently, the necessary resolutions were passed to increase the capital of the company as indicated by the chairman, and various formal alterations were made in the articles of association.

Evered & Co., Limited.

The directors' report for last year reads:—

Your directors submit the annexed balance-sheet, showing, after providing for debenture interest, amounting to £2,385 8s. 4d., income-tax, £1,563 10s., and auditors' and directors' fees, a net profit of £18,251 19 7
making, with £6,986 0s. 9d. brought forward from 1899, the sum of £25,238 0 4
to be dealt with.

An interim dividend at the rate of 7½ per cent. per annum, to June 30th, 1900, has been paid, absorbing	6,402	18 0
And your directors propose		
To pay a dividend at the rate of 7½ per cent. per annum for the remaining six months, which will absorb	6,402	18 0
To pay a bonus of 2½ per cent. per annum for the year	4,268	12 0
To write off plant	1,000	0 0
To write off buildings	1,000	0 0
To carry forward to next account	6,163	12 4
	£25,238	0 4

In presenting the above report the directors have pleasure in stating that the volume of the company's business has been maintained, but at a less profitable rate as compared with former years, owing to the advance in prices which could be obtained being inadequate to cover the largely increased cost of materials, fuel, &c. Messrs. J. D. Davenport and W. G. Kent are the retiring directors, and being eligible, offer themselves for re-election. The re-appointment of the auditors, Messrs. Chatteris, Nichols & Co., is recommended.

W. T. Glover & Co., Limited.

The annual meeting was held at the company's new works in Trafford Park, Manchester, on Wednesday.

The Chairman (Mr. H. Edmunds), in moving the adoption of the report, said that the company had done more trade last year than ever, notwithstanding that they had had to remove their business during that period. Indeed, he feared that by the time they were in full working order at Trafford Park, they would require to double their works. They were now considering whether it would not be advisable to bring in outside capital, and negotiations were going on for the disposal of the power and light distributing property on favourable terms with immediate and future profit. They had received from the Salford Corporation the largest single order ever given in connection with electric lighting.

Dividends of 10 per cent. on the ordinary, and 5 per cent. on the preference shares, were agreed to.

National Electric Wiring Company.

The directors' report reads as follows:—

The directors submit their report and statement of accounts to December 31st, 1900. The gross profit for the period under review is £9,636 0s. 2d., from which has to be deducted expenses of administration, allowances on contracts, &c., amounting to £5,642 4s. 8d., leaving a balance of £3,993 15s. 6d. To this has to be added the balance carried forward at December 31st, 1899, viz., £281 1s. 5d., making a total of £4,274 16s. 11d. The directors recommend that this amount be dealt with as follows:—

To pay a dividend at the rate of 4 per cent. on the paid-up capital for the year	£2,499	11	8
Provision for further allowances, depreciation, &c.	1,390	19	6
To carry forward	384	5	9
	£4,274	16	11

The directors have pleasure in stating that the increase in business during the year has been very satisfactory. The orders taken from January 1st of the current year to date of this report show that the increase has been more than maintained. Several large contracts have been secured by the company, involving the complete equipment of plant necessary for power and lighting. During the year 2,240 installations with an aggregate of 57,519 lamps of 8 c.p. have been completed, of which 777 installations with an aggregate of 19,973 lamps of 8 c.p. were free wiring, and 1,463 installations with an aggregate of 37,546 lamps of 8 c.p. were contract, while the orders in hand at the close of the year were 690 installations with an aggregate of 33,084 8-c.p. lamps. Free wiring contracts have been entered into with the Corporation of Swansea, the Borough of Poplar, and the Scottish House-to-House Electricity Company, Coatbridge. Mr. R. Stewart Bain and Mr. B. Bernheim, in accordance with the articles of association, retire at this meeting, but are eligible, and offer themselves for re-election. Messrs. Monkhouse, Stoneham & Co., the auditors, also retire at this meeting, but offer themselves for re-election. The dividend warrants will be sent out on April 1st.

Bournemouth and Poole Electricity Supply Company.

Mr. A. H. Sanderson presided over the annual meeting held at Moorgate Court, E.C., on Tuesday. In moving the adoption of the report, he stated that £1,500 had been added out of revenue account to the depreciation fund, which now stood at £3,704. Capital expenditure during the year had been £26,342, which included £13,581 on new machinery necessary to keep pace with the increasing demand; mains had cost £7,840, because they had gone in for a very forward policy by laying mains throughout Bournemouth, a policy which had been highly satisfactory; £2,125 had been spent upon buildings to accommodate the new machinery. Capital expenditure now stands at £169,572. The revenue from sale of current was £16,428, against £13,299 for the year 1899. Revenue from all sources was £17,504, an increase of £3,038. Coal and other fuel had cost £3,197, which was a serious item, and showed an increase of £1,257 on the previous year. The increased cost per ton, and the increased consumption, accounted for this. Comparing the revenue charges with the past year, there was an increase of £1,964 over 1899. Coal was responsible for this. After paying preference dividend, there was 6 per cent. to be paid on the ordinary shares. The Bournemouth Corporation's Bill, applying for powers to supply energy in competition with this company in respect of private lighting, had been refused, but the Corporation had secured an order enabling them to supply current for public lighting in Bournemouth. As this company had never done any public lighting there it was not prejudicially affected by their holding that order. The chairman then read out statistics showing the increase of lamp connections and units consumed from 1891 to 1900. The new lamps applied for last year were 10,498, and the units sold were 671,762. The business was increasing very rapidly, and there was a very bright future before the company. The contract entered into with the Bournemouth and District Electric Traction Company to supply it with current to work its tramway between Poole and the County Gates at Bournemouth would give them a day load and reduce the all-round costs of the generation of current during years to come. They were already in receipt of revenue in respect of the tramway, it having commenced on January 1st, and since March 1st they were entitled to the minimum payment for current supply of between £1,100 and £1,200, although they had not begun to supply current regularly. They had invested a further £4,650 in the Richmond Supply Company, and their interest in that company now stood at £84,000. The Richmond Company continued to make satisfactory progress. The lamps applied for during the year were 4,171 8-c.p. as against 1,981 increase in 1899. The directors had declared 5 per cent. dividend on the ordinary shares against 4 per cent. in 1899. The company had during the year opened up an entirely new district and had carried its mains into Kew. The district was a residential one, with houses of a good class. The mains were not completed until the end of the year, so that the accounts did not benefit much therefrom for 1900. The Bournemouth Company had a provisional order for lighting Poole and

Parkestone. The carrying out of this order was now to be seriously considered. In the area mentioned there was a large and remunerative field. When that work was carried out they would have to raise additional capital.

Dr. Hosker seconded the motion, which was carried. The retiring directors and auditor were re-elected, and a vote of thanks to the board and staff was passed.

The meeting then passed a resolution effecting certain alterations in the articles to bring them into line with the new company's Act.

Brush Electrical Engineering Company.

The directors' report to be presented to the annual general meeting to be held at Winchester House to-day reads as follows:—

The directors herewith submit the balance-sheet and profit and loss account for the year ended December 31st, 1900. The profit and loss account shows an available gross profit of £61,732 8s. 9d. After deducting maintenance, general charges, interest on debenture stock, and interim dividend on preference shares for the half-year ended June 30th last, there remains a balance of net profit of £24,070 0s. 8d.

The directors recommend that this sum be applied as follows:—

To dividend at the rate of 6 per cent. per annum on preference shares for the half-year ended December 31st, 1900	£5,948	3	6
To dividend at the rate of 5 per cent. per annum on ordinary shares for the full year ended December 31st, 1900	9,521	8	9
To bonus payable to employés under profit-sharing scheme	2,098	1	7
To depreciation reserve fund	5,000	0	0
To balance carried forward	1,502	6	10
	£24,070	0	8

Capital expenditure to the extent of £68,067 2s. 11d. has been incurred during the year.

The extensive additions to the company's works and plant at Loughborough, which have been in progress during the past three or four years, are now virtually complete, and the directors anticipate that the company will reap the benefit of the large expenditure that has been made on capital account in the increased facilities for economical manufacture which the works now afford. Complete electric cars, comprising trucks, motor equipments, controllers, and car bodies are now being manufactured at the company's works, and the directors continue to look for a large and increasing business in connection with electric traction. In order to provide for the expenditure on capital account the directors have decided to offer for subscription 12,500 preference shares of £2 each, and 20,000 ordinary shares of £2 each, particulars of which will be announced shortly. The company's profits have been prejudicially affected during the past year by the high price of coal and materials generally. In pursuance of the agreement dated January 3rd, 1901, between the company and the British Electric Traction Company, Limited, adopted by the shareholders in general meeting on January 14th, 1901, Mr. A. Ayres, Mr. A. H. Sanderson, Col. F. G. Steuart, and Mr. E. Woods resigned their seats on the board, and Mr. C. Shirreff B. Hilton and Lord Vaux of Harrowden, nominees of the British Electric Traction Company, were elected as directors. Mr. R. Percy Sellon also resigned his position as general manager of the company, and was elected to a seat on the board. The offer of the British Electric Traction Company, Limited, to issue ordinary shares in exchange for ordinary shares of the Brush Electrical Engineering Company, Limited, on the terms set out in the agreement of January 3rd, 1901, above referred to, has resulted in their acquiring 15,584 ordinary shares of the company. In consequence of an informality, the appointment of Lord Vaux of Harrowden and Mr. C. Shirreff B. Hilton as directors of the company has become void. Mr. E. A. Hopkins and Mr. Reginald Ryley have been elected to fill the casual vacancies thus occurring on the board, and Lord Vaux of Harrowden and Mr. C. Shirreff B. Hilton will be proposed to the shareholders for re-election at the general meeting. The retiring directors are Mr. J. B. Braithwaite, jun., and Mr. C. E. Hodgkin, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers & Co., also retire, and offer themselves for re-election.

An extraordinary general meeting follows for passing resolutions altering the articles.

British Columbia Electric Railway Company.

Mr. A. C. Mitchell Innis presided over an extraordinary general meeting of this company held at Cannon Street Hotel on Monday. In moving the following special resolution:—

That the articles of association be amended by the insertion after Article No. 50 of the following:—

50A. "Upon any offer of shares to the public for subscription the company, or the directors on behalf of the company, may pay a commission at a rate not exceeding 10 per cent. to any person in consideration of his subscribing or agreeing to subscribe, whether absolutely or conditionally, or procuring or agreeing to procure subscriptions, whether absolute or conditional, for shares in the company."

the Chairman said that theirs was a prosperous and progressive enterprise, and in view of the great strides the business was making, and the large number of new electric lighting consumers they had secured, they required more capital. If the next report did not show up quite so well as the last, it would come within £200 or £300. The great difficulties experienced this year had caused an increase of £2,000 or £3,000 in the working expenses, which would not occur in future years, and but for this there would have been a great increase in the net earnings as compared with the previous year. The storms towards the end of the year entailed a loss of £1,500, and non-delivery of machinery caused trouble and loss—they had connected new consumers ready for the winter, but the additional machinery ordered did not come to hand, so that they had to use the reserve steam plant, increasing the cost of production. The light they were able to supply at that time was inferior. Now, however, these things had been altered, for they had ample machinery and were looking ahead. They were to provide further rolling stock and car house accommodation, but they would see that the 5 per cent. preference yield was certain when entering upon any new capital expenditure. The amount of money required for machinery and stock contracted for, and for further contemplated extensions, would be something less than £40,000, but they proposed to raise the whole £64,000, as it was desirable to have a reasonable proportion in a liquid state to meet any emergency that might arise. The outlook at British Columbia for improving the business had never been better. They believed they were on the eve of another big step forward in British Columbian commerce. They had received an unsolicited offer to underwrite the present issue of preference shares from one of the great Canadian banks. The present issue would not, in his opinion, prejudice the position of the ordinary shares, but would improve the outlook for them.

The resolution was adopted.

Willans & Robinson, Limited.

The directors' report to be submitted at the meeting to be held at Cannon Street Hotel on Wednesday, April 3rd, reads:—

The accounts for the half-year ended December 31st, 1900, are submitted herewith. After writing off as depreciation from plant, patents, &c., the sum of £5,855 15s. 8d., and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year (including £6,757 2s. 11d. brought forward) is £39,360 19s. 10d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and 10 per cent. per annum upon the ordinary shares, and that a bonus of 2 per cent. be paid upon the ordinary shares for the year 1900, the whole amounting to £20,761 16s. 11d. The amount payable to the original directors, in accordance with the articles of association, being £5 686 16s. 5d., the balance available is £12,912 6s. 6d. From this the directors propose to carry £2,000 to the debenture redemption fund, and £3,500 to the reserve fund, leaving a balance of £7,412 6s. 6d. to be carried forward. The auditors having questioned the propriety of investing the debenture redemption fund (the creation of which is a voluntary act on the part of the company) in the names of the trustees, and thus placing it beyond the control of the company, the directors have taken counsel's opinion, and are advised that future investments should be in the company's name. The necessary alterations have been made in the accounts. The opinion of counsel and of the auditors has also been taken, as promised at the last meeting, upon the questions then raised as to the appropriation of share premiums. Copies of the opinions, and of other papers relating thereto, have been circulated among the shareholders. It will be seen that counsel and the auditors consider that the proposed applications of the premiums (which they say are profit, and not capital) to meeting various exceptional expenses, are in accordance with the articles of association. The proposal to carry a portion of the premiums to the reserve fund is in accordance with general practice, and under ordinary articles of association such profit may lawfully be divided among the shareholders. But in view of the special wording in one of this company's articles, counsel think that the distribution of premiums as dividend is open to question. This opinion is consistent with carrying premiums to the reserve fund, as proposed, it being only necessary to take care that any amount so carried shall not be distributed. It will be seen that a further question arises as to the remuneration of the original directors, and (as regards a certain limited period) the remuneration of the staff. Under the circumstances the balance of the share premiums account, amounting to £27,440 2s. 4d., is again carried forward. The growth of the business in the past two years has largely diverted to more pressing uses the additional capital intended for new buildings and plant. Between December, 1898, and December, 1900, while the value of buildings and plant increased by about £78,000, the floating capital of the business, including the sums locked up in stock of all kinds, in work in progress, and in balances owing by debtors, increased by no less than £115,000. In the opinion of the directors, this growth is only the natural consequence of the increased volume of the company's trade, and is justified by the increased profits of the same period. But it results that if the extensions of premises and plant, which are more than ever necessary and to which the company is, in fact, committed, are to be properly carried out, and especially if the new boiler works near Chester are to start upon the scale plainly desirable, the capital of the company must be increased. With this object a resolution will be submitted authorising the creation of new shares (in equal proportions of preference and ordinary shares) to raise the share capital from £500,000 to £750,000, to be issued not necessarily at once, but as may be required. The first portion of the extension works at Rugby is nearly completed. Work has been commenced in the new part of the foundry, and the fixing of tools in the new machine shops will begin shortly. The boiler works at Queensferry make good progress. The Admiralty has ordered Niclausse boilers to be fitted in the new armoured cruiser *Suffolk*, of 22 000 H.P., and in a second of 1,400 H.P. The directors consider that the interim report of the Admiralty Boiler Committee, recently published, is likely to have favourable results upon the future of the Niclausse boiler. Captain H. Riall Sankey, R.E. (Ret.), and Mr. Thomas Orger Lazenby retire from the board in accordance with the provisions of the articles of association, but are eligible, and offer themselves, for re-election. The auditors, Messrs. Cooper Brothers & Co., also retire, but are eligible for re-election.

Direct Spanish Telegraph Company.

The Marquis of Tweeddale presided at the meeting held at the offices on Tuesday, and in moving the adoption of the report, said that the result of the year's operations was a profit of £10,817, which, after placing £5,000 to reserve, enabled them to recommend the usual 10 per cent. on the preference shares, and 4 per cent. on the ordinary. The dividend will be paid out of revenue, and no portion would be taken from the contingencies account as occurred last year. The reserve fund, after deducting the cost of repairs to the Bilbao cable, and the renewal of the underground cables there, amounting to £8,515, together with a small loss incurred on the realisation of one of the company's investments, stood at £55,243, or £1,627 less than on January 1st last year. The traffic accounts for the year showed an increase of £1,029. This would be considered satisfactory when it was borne in mind that the Bilbao cable was interrupted 36 days during the year. Although they had a very excellent agreement with the Eastern Telegraph Company, yet the benefit of that agreement did not compensate them for the loss which arose through the interruption of that cable. The ordinary expenses showed a decrease of £210. A small sum had been expended upon improvements at the Barcelona station, and also upon automatic apparatus which would greatly increase the carrying power of the cables. There had been two serious interruptions in the Falmouth—Bilbao cable during the year, the removal of which cost £6,529. From the officers in command of the repairing expedition they learnt that the cables were found in excellent order, excepting in the immediate vicinity where the faults occurred. There was every reason, owing to the change in the position of the cables and the introduction of a considerable amount of new cable, to hope that there would not be in the immediate future any demand for renewal. The expenditure of £1,539 for relaying the underground wires at Bilbao was for the purpose of maintaining in first-rate condition the connection between the shore end of the cables and the telegraph apparatus. The work was carried out by the company's own officers. He regretted to say that since the beginning of the year the Barcelona cable had been interrupted, and owing to the extremely bad weather which had prevailed in the south of

Europe, that interruption had not been removed up to this date. The weather now showed signs of improvement, and they had every hope that the fault would be repaired in the course of a few days. The cost of the repairs at Bilbao would amount to £4,200, and these and the other repair would make serious inroads upon the reserve fund. It would probably be depleted by April next by certainly not less than £10,000. So long as they maintained the reserve at a substantial figure there was no need to be apprehensive as to any results to the company from such interruptions.

The resolution was seconded by Mr. J. D. Pender and carried.

Other motions declaring dividend, re-electing director and auditors, and thanking the board and staff were also carried.

City of London Electric Lighting Company.

Sir David L. Salomons, Bart., chairman, presided on Thursday last week, at the Cannon Street Hotel, over the annual meeting of the above company, and in moving the adoption of the report, said he appeared before them that day to make a statement respecting the affairs of the company which he trusted would be reassuring, notwithstanding the small amount of profit which they had made at the end of 1900. The main point which called for remark in the report is the table of figures showing the average prices per unit obtained. They would observe that the average price had steadily gone down, till last year it reached 4·09d. per unit. It was this figure, combined with two other circumstances, which had rendered the payment of a dividend on the ordinary share capital impossible on this occasion. The two other circumstances were—first, the price of coal, and secondly, the working costs. The increase in the gross revenue for 1900 was £35,031, but the increased expenses amounted to £39,830, made up as follows:—Coal, £34,000; wages and other details, £3,000; rates and taxes, £1,100; and various other items, £1,630. Consequently, although their business had enormously increased since the previous year, there was an actual loss in the net revenue, as compared with 1899, of £4,799. The amount of coal used last year exceeded 75,000 tons, at an average price of 20s. 9d. per ton. In 1899 the average price was 14s. 10d., and it was as well to bear in mind that a drop of 5s. per ton is equal to rather more than 2½ per cent. on the ordinary shares for the same amount of coal. The third point, viz., working expenses, having been unduly high, was a matter which was closely claiming the attention of the board. The permission which had been given to the board to raise further capital had been acted upon. The money had been laid out in the most careful manner, and they believed that a large economy would result in consequence. It was well, therefore, to look a little ahead and see what were their prospects for the year now passing. With the new tariff a considerable increase in the receipts should ensue. Coal had already begun to fall in price. The economies now being effected would considerably reduce the working costs, and they would therefore realise that their prospects for this year were brighter. He would point out that 1d. per unit was equal to £50,000 on an output of 12,000,000 units—an output they almost reached last year, or, say, 7 per cent. on the issued ordinary share capital. He would like once more to refresh their memory respecting contracts made between the company and the City of London. No questions were raised about the validity of the contracts until prosperity followed their footsteps. Then certain members of the Corporation started the hare, and eventually discovered that some three gentlemen held shares in the company to a mere nominal extent. One of these gentlemen had purchased 100 shares before the contracts were made and took them up afterwards, another was the owner of 200 shares, and another of 50 shares. The shares were at that time £3 nominal, and were not at a premium, so that three of the Corporation held 350 shares worth under £1,000, and on this they tried to upset those large contracts in a wealthy city like that of London. They sought to take advantage of their own wrong, which, according to the first principle of English law, no person had the right to do. But there happened to be a certain Act which abrogated this national law of justice in favour of the Corporation of the City of London. He would not criticise the action of the authorities, or he might say something which he might afterwards regret. The company applied to the Courts to declare the contracts valid, as it was simply impossible for the two parties to go on working when one declared that the contracts were invalid. In the Court of first instance Mr. Justice Farwell declared for them all along the line. The City were compelled to appeal, and the result of the appeal to the next Court was that the honours were divided. The company gained the eastern portion of the City, which was equal to about half of the whole of the City, whilst they lost the contracts in the western and central part of the City. There was one point satisfactory in this. In the contracts, the City at that time undertook not to compete, and to practically give the company a monopoly as far as they were able. Therefore, the Corporation could not compete against them in the eastern portion of the City. Under the circumstances, and on proper advice, the board had decided not to appeal against the last decision. They did not know yet what the City would do—whether they would appeal or not—but it seemed very doubtful if they would do so after the decision of the judges in the Court of Appeal. But that decision complicated matters very much. They had a contract with the City for public lighting at so much per lamp, and therefore there was no contract in existence in the western and central portion of the City. They were now negotiating with the City, and they trusted they would make a satisfactory arrangement for the lighting of those parts. He could not tell them more about that. But there was a point which might arise in their minds, viz., whether by the decision the company had lost their ordinary rights in the western and central portions of the City. Their provisional order to supply the City was in no way upset, and they were now in the City in exactly a similar position as a company in any other district where there was no contract whatever with the local authority. The general business of the company was not touched whatever. It was merely a question of public lighting and some smaller incidents. It was important to this extent. If they were not to have the City competing with them with the ratepayers' money, it was important that they should have the contract binding in some portion of the City, and, so far as that went, they had the eastern portion of the City. He thought that even if the Corporation did go to the House of Lords, and did get a decision in their favour, that Parliament would not allow the City to compete. With regard to the rating question, he thought they were treated in an unfair way. In Southwark, where their works were situated, in 1895, they were assessed at £6,348; in 1896, at £8,000; in 1899, at £11,092; and this year they were rated at £18,225. When they remembered that something like 6s. or 7s. in £ was paid for local rates, it would be seen that it was a considerable item to a company whose coffers were not well filled with coin. The state of things appeared most unjust, because it was common sense that ratable value and letting value ran together, and surely the letting value of that company's works would be considerably less in a year with no dividend than in a favourable year. Notwithstanding that, they had been put up £7,000, and they had not even a vote in the spending of that money. They had appealed against this, and trusted that they would get fair treatment before the Committee. The additional machinery which they had placed in their works was for the production of continuous current, which simplified the work to a great extent, and was also more efficient. Up to March 6th there were 540,389 8-c.p. lamps (equivalent) applied for. He could only say that whatever questions the shareholders might ask, there was no money to pay them, and none regretted this more than the members of the board, who were large shareholders in the company.

Col. Martindale seconded the motion.

Mr. Hicks wished to know whether the board proposed appealing to the House of Lords?

Mr. Fitch said he would like to know by whose advice the price for current was reduced, for they would have had a dividend of 8 per cent. had it not been for the reduction. When the Charing Cross and Strand Company's Bill was before Parliament, it was stated that it could not be supplied profitably under 5d. per unit, but last year the average rate was a little over 4d. per unit, which represented a very serious loss to the shareholders. It seemed to him a great pity that the rate was reduced.

Mr. Young complained of the shameful action of the City Corporation, who, he contended, had broken contracts solemnly entered into, and had set a bad example not only to other corporations, but the whole business community. He was a large shareholder and risked his money to do for the City what the City at that time was afraid to do for itself. There was no question of the contracts until the company became prosperous. The matter seemed to be taken very quietly by the people of London, but he could assure them that in Liverpool, where he came from, it was talked of, and the opinion was there expressed that the members of the Corporation had acted in a manner in which they would not dare to act in their private capacity.

Mr. Jackson asked if the expenses of the law cases had been paid.

Mr. Bailey said he was the town clerk of a large Northern borough, and they had been in the habit of looking at the City Corporation as leaders of commercial morality, but their faith had been greatly weakened by the way the Corporation had treated the company. He would suggest that the Corporation should reconsider its position and enter into contracts on somewhat similar lines to those which they had repudiated.

Mr. Gundry thought that while it was true that the company had been badly treated by the Corporation, yet at the same time they ought to be able to earn dividends on their own merits. It must be a valuable business, as was proved by the anxiety of other people to compete. The Charing Cross and Strand Company spared no effort until they came in to compete, and if the City of London Company were not careful they would be beaten on their own ground. He thought fresh blood was needed on the board.

The Chairman, replying to these and other questions, said they had 12 months in which to give notice of appeal. They did not know yet what the City was going to do, but the board had decided not to appeal as things stood that day. If the Corporation could not come to any reasonable terms with them, it might be advisable to appeal. It was not a question of money with the board, but of policy. He could not exactly put before them all the details which moved them to reduce the rate, but there were reasons which induced them to do so when the Bill of the Charing Cross Company was before the House of Commons. As it happened, it had resulted in a loss to them, and it was a thing which they could see now was a mistake. Still, it was possible that if their rates had been kept up they might have lost all their customers, and whatever the loss might be now, in the end it might have the result that they would keep on their circuit the bulk of their customers. It was extraordinary, so far, how few of their customers had left them for the Charing Cross Company. All the law costs had been paid except the appeal case. With regard to the publication of the fact that no dividend would be paid before the report was issued, that was simply carrying out the practice of all the railway companies, and was done to prevent any possibility of speculation in the shares.

The motion was then carried, and the retiring directors and auditors were re-elected.

The meeting then proceeded to consider a number of resolutions for altering the company's articles of association, in order to bring them into conformity with the Companies' Act, 1900. The only resolution on which there was any discussion was the third, viz.:—

"Upon any offer of shares to the public for subscription, the company may give to any person in consideration of his subscribing, or agreeing to subscribe, whether absolutely or conditionally, for any share in the company, or procuring or agreeing to procure subscriptions, whether absolute or conditional, for any share in the company, such commission as the directors may from time to time determine, provided that the rate per cent. of the commission paid, or agreed to be paid, shall not exceed 100 per cent. of the nominal amount of such share."

Mr. Candler wished to add words to the resolution to the effect that the amount agreed to be paid for commission should be disclosed on the prospectus.

The Chairman pointed out that this was in the Act, and must appear, and Mr. Candler withdrew.

Mr. Gundry moved, and Mr. Harvey seconded, an amendment that 10 per cent. should be substituted for 100 per cent.

Mr. Braithwaite said that this would be against the interests of the shareholders. If the shares of the company went up to 20 again, and they had a new issue, they would be unable to offer shares to shareholders at par if the clause was offered.

After some discussion the amendment was withdrawn and the clause agreed to.

After the conclusion of the business, the Chairman said it was absolutely necessary that he should take a year or two's complete rest, and therefore he was about to retire from the position of chairman of the company which he had held for many years. He would have retired a considerable time ago but he saw rocks ahead, and he was not one to desert a ship in need. Now, however, he thought the corner was turned, and that he was, therefore, free to resign. His opinion was that the troubles of the company in the future would be fewer than those of the past, and unless something quite unforeseen happened there would be a dividend for the ordinary shareholder at the end of the year. His private opinion was that the chairman of that company should hold aloof from taking part in industrial or financial undertakings coming into contact with the company, and he had carried that out himself. He would urge them to keep in their service the officers who had served them so loyally and so well in the past. He hoped they would shortly be able to have the continuous current system in every part of the City, for no system was more free from complications, and more suitable for the metropolitan areas where the generating station was near. He saw no reason why the company should not develop into a steady dividend-paying concern.

A hearty vote of thanks to the chairman concluded the proceedings.

County of London and Brush Provincial Electric Lighting Company.

The directors' report which was presented to the meeting held at Winchester House yesterday (Thursday), reads as follows:—The directors beg to submit their report and statement of accounts for the year ended December 31st, 1900.

Capital.—The capital expenditure during the year, on account of the company's London districts, amounted to £174,481 3s. 4d., making the total expenditure in respect of those districts up to December 31st last £892,677 2s. 3d., particulars of which are given in capital accounts Nos. 5, 7, 9, 11, 13 and 15. This expenditure was met in part by the issue, in July, 1900, of a further £100,000 4½ per cent. debenture stock, at a premium of £8 per cent. The premium received on the above-mentioned issue has been placed to reserve for depreciation, repairs, and renewals.

Revenue.—Balance from last account after payment of the final dividend on the preference shares for the half-year ended December 31st, 1899, less income-tax, and of the dividend of 4 per cent. on the ordinary shares for the year ended December 31st, 1899, less income-tax ... ... £ 12,594 s. 2 d. 8

Balance from revenue account No. II., after payment of directors' fees, rent, taxes, general establishment and other charges, wages, and proportion of salaries 27,367 19 7

Making a total available revenue for the year 1900, of 39,962 2 3

From which must be deducted the following items:—

(a) Interest on debenture stock, including interest on instalments paid in advance	£9,606	14	10
(b) Interim dividend on 20,000 6 per cent. preference shares for half-year ended June 30th, 1900, less income-tax	5,750	0	0
(c) Interim dividend on 40,000 ordinary shares at 4 per cent. per annum for half-year ended June 30th, 1900, less income-tax	7,666	13	4
		23,023	8 2

Leaving for further distribution £16,938 14 1

The directors recommend:—

(a) That payment of the interim dividend on the 20,000 6 per cent. preference shares for the half-year ended June 30th, 1900, less income-tax, be confirmed.
(b) That payment of the interim dividend on the 40,000 ordinary shares at the rate of 4 per cent. per annum for the half-year ended June 30th, 1900, less income-tax, be confirmed.
(c) That a further dividend on the 20,000 6 per cent. preference shares for the half-year ended December 31st, 1900, less income-tax, be declared, and
(d) That a further dividend on the 40,000 ordinary shares for the half-year ended December 31st, 1900, at the rate of 4 per cent. per annum, less income-tax, be declared, and that the same be paid to all proprietors registered at March 19th, 1901.

This will absorb £13,300, and leave a balance of £3,638 14s. 1d. to be carried forward. Notwithstanding the high price paid for fuel during the greater part of the year, the profits derived from the City Road station have risen from £8,707 7s. 9d. in 1899 to £17,239 0s. 3d. in 1900, being an increase of 98 per cent., while at the Wandsworth station the profits have risen from £11,136 10s. in 1899 to £15,624 8s. 5d. in 1900, an increase of 40 per cent. The equivalent number of 8 c.p. lamps applied for during the year was 102,003, as against 58,523 for 1899; and the units sold were 2,990,138, against 1,766,515 for the previous year. The directors are glad to report that, as a result of this satisfactory progress, they are this year enabled to recommend a dividend out of the earnings of the company's London stations without assistance from the further realisation of any of the company's investments. These results reflect great credit upon the chief engineer, the secretary, and the company's staff. The retiring directors are Mr. F. E. Savory and Mr. Joseph Shaw, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

London Stations.

St. Luke and Clerkenwell, Eastern Holborn, Western Holborn and St. Giles.—The balance to credit of revenue for the 12 months ended December 31st, 1900, amounted to £17,289, details of which are given in revenue accounts Nos. 6, 8 and 10. In these districts, the total applications to December 31st last, including power, represented the equivalent of 143,195 8-c.p. lamps, of which 119,076 were then connected to the mains. The applications for the year represented an increase of 62,272, and the connections an increase of 57,888. At the same date 165 users of motors, aggregating 1,171 h.p., were supplied from the company's mains, showing an increase of 798 h.p. for the year, and further applications have since been received, raising the total to 214 applications, representing 1,941 h.p. The special plant erected for the generation of continuous current for power purposes will shortly be insufficient, and further machinery has been ordered to meet the rapidly increasing demand. Additional plant for the lighting supply has also been ordered for delivery in time for next winter. The Board of Trade granted a Competing Order, which was confirmed in the last session of Parliament, to the local authorities in the company's East End districts, and your directors have accordingly lodged the company's claim for compensation as provided for under the Order referred to.

Wandsworth District (including the Parishes of Putney, Wandsworth, Clapham, Streatham and Tooting), *Camberwell and St. George-the-Martyr, Southwark.*—The balance to credit of revenue for the 12 months ended December 31st last amounted to £15,624, details of which are given in revenue accounts, Nos. 12, 14 and 16. In these districts the total applications to December 31st last represented the equivalent of 96,607 8-c.p. lamps, of which 90,472 were then connected to the mains. The applications for the year represented an increase of 39,731, and the connections an increase of 35,825. In order to meet the increasing demand in these districts, additional plant has been erected at the company's station on the Wandle.

Investments in Provincial Electricity Supply Companies.

The Bournemouth and Poole Electricity Supply Company, Limited.—This company continues to make satisfactory progress The directors have recommended the payment of a dividend on the ordinary shares of the company at the rate of 6 per cent. for the year ended December 31st, 1900, less income-tax, as against 5 per cent. for the previous year.

The Dover Electricity Supply Company, Limited.—This company has made satisfactory progress during the past year. The balance from revenue account for the year ended December 31st last has allowed the payment of a dividend on the share capital of the company at the rate of 8½ per cent. per annum, as against 8 per cent. for 1899.

The Scottish House-to-House Electricity Company, Limited.—Satisfactory terms have been arranged for a transfer to this company of the Electric Lighting Order for the adjoining borough of Airdrie, and an agreement has been entered into with the Airdrie Corporation for both public and private lighting. The company has also acquired the interests of the Airdrie and Coatbridge Tramways Company in the Airdrie and Coatbridge Tramways Act, 1900, and is promoting a provisional order in the present session of Parliament, under agreement with the Coatbridge Corporation, for the construction of tramways in Coatbridge.

Liverpool District Lighting Company.

The report for the year ending December 31st, 1900, states that the supply of electricity at Waterloo shows satisfactory progress, the number of lamps connected at the end of the year being 6,294, as against 4,243 at December 31st, 1899, an increase of nearly 50 per cent. The revenue from this business during the same period has increased from £1,504 to £2,388. Owing to the advances in the price of fuel, the resultant profit has not come up to expectations. In accordance with a resolution passed at the extraordinary general meeting in March last, the company have sold the Gateacre portion of their business to the Garston Electric Supply Company, Limited, for the sum of £20,000. Of this amount £10,000 has been received, and the balance is to be paid on or before June 1st next, together with interest at the rate of 5 per cent. per annum. A fair amount of contracting and manufacturing business has been secured by the company, but owing to the keen competition prices for this class of work are very low. The company have made it a rule that only the very best class of material should be used and thoroughly good workmen employed, and think that their clients are beginning to appreciate this fact. The total profit for the year amounts to £961 18s. 8d., of which £472 6s. 5d. has been applied to depreciation and £100 deducted from Parliamentary expenses, leaving, with the balance from 1899, the sum of £651 4s. 11d. to be carried forward.

Norwich Electricity Company.

The annual meeting of this company was held last week, Sir Charles Gilman presiding.

The Chairman, in moving the adoption of the report, thought there was cause for congratulation in being able to present so good a report. The continued increase in the amount of the company's business was entirely satisfactory, the advance being about £3,000 over the previous year. Against this, however, they had to set the great advance in the price of coal, and consequently they had not derived the benefit they should otherwise have done from the increased income. However, he thought the general result extremely satisfactory, there being a balance in hand of some £930 more at the end of the year than 12 months ago, which showed the progressive state of the business. The extension of their business naturally led to a large increase in mains and machinery to provide for the wants of their new customers, thus necessitating a considerable capital outlay, as it was necessary to have the latest and best kind of machinery. The outlay for the past year on this account had been met by loans from the company's bankers, and it was now intended to issue a further number of shares which would enable them to repay this loan and provide the necessary means for increasing the mains and machinery during the current year.

Mr. Wild seconded the adoption of the report. He thought to

keep up a 6 per cent. dividend in such a company as this was a thing not to be despised, especially in view of the very large increase in the expenditure for coal during the last year. Although they were unable to increase the dividend there was a set off in the issue of the new shares, as a very considerable bonus was given in offering the new shares at the low figure of £14, which was much below the market price. The necessity for issuing new capital of course arose from the want of machinery, and it might be asked when was this to come to an end. He did not know if it ever would. It was one of the necessities of electric supply that as demands come on fresh capital must be raised, so that the wants of the city might be supplied, and he hoped the city would go on extending.

Imperial Tramways Company.—Mr. George White, who presided at the meeting of this company held at Bristol on Saturday, in moving the adoption of the report made a few remarks regarding the Darlington and Reading tramways. He then referred to the Middlesbrough, Stockton and Thornaby electric tramways undertaking, which showed a quiet but steady growth. The London United Tramways Company's undertaking, in which the Imperial Company had taken a further interest during the past 12 months, had made great strides during this period in the various construction works which have been carried through, as well as in the large additional territory which they had secured from Parliament. They had met with obstacles of every possible kind, but, without going into the details of the exact position at the moment, they had good grounds for believing that they would be able to give to Londoners the benefit of an important electric traction scheme in their western suburbs during the next few weeks.

Stock Exchange Notices.—Application has been made to the committee to appoint a special settling day in and to grant a quotation to—Cape Electric Tramways, Limited.—Further issue of 40,000 shares of £1 each. The committee has further been asked to allow the following to be quoted in the Official List:—Buenos Ayres and Belgrano Electric Tramways Company, Limited.—£120,000 5 per cent. second debenture stock, in lieu of provisional certificates now quoted.—100,000 ordinary shares of £5 each (special application). Kensington and Knightsbridge Electric Lighting Company, Limited; and the Notting Hill Electric Lighting Company, Limited.—Further issue of £26,991 4 per cent. debenture stock.

Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. per share (3 per cent. per annum) for the quarter ending March 31st, 1901.

Globe Telegraph and Trust.—The directors have declared an interim dividend of 2s. 6d. per share on the ordinary shares.

Richmond (Surrey) Electric Light and Power Company.—The meeting of this company was held at Moorgate Court on Tuesday last. The proceedings were private, and we were not allowed to have a copy of the directors' report.

Held Over.—The great pressure upon our space this week compels us to hold over a number of directors' reports and meetings.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending March 22nd were £407; corresponding week last year, £370; increase, £37 Total to date, £4,662; corresponding period last year, £4,223; increase, £439. Miles open, 8¼. Partly electrical and steam.

Blackpool and Fleetwood Tramways.—The receipts for the week ending March 23rd were £162; corresponding week last year £188; decrease, £26. Total to date, £1,736; corresponding period last year, £1,872; decrease, £136.

Bristol Tramways and Carriage Company.—The receipts for the week ending March 22nd were £3,575 15s. 1d.; corresponding period last year, £2,400 13s. 7d.; increase, £1,175 1s. 6d.

Central London Railway.—The receipts for the week ending March 23rd, were £6,188; previous week, £6 157; increase, £31. Total receipts to date (12 weeks), £73,007. Miles open, 6.

City and South London Railway.—The receipts for the week ending March 24 h were £2,0-2; corresponding week last year, £1,953; increase, (Moorgate extension open) £729. Total to date, £24,236; corresponding period last year, £14,579; increase. £9,657. Miles open, 1901, 4½; 1900, 3¾.

Dover Corporation Tramways.—The receipts for the week ending March 23rd were £154 18s. 1d.; corresponding week last year, £137 8s. 9d.; increase, £17 4s. 4d. Total to date, £1,844 17s. 9½d.; corresponding period last year, £1,723 14s. 1½d.; increase, £121 3s. 8d. Miles of track open, 3; Car miles run, 1901, 4,981; 1900, 4,589. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending March 22nd were as follows:—D. U. T. Co., electric cars, £3,076 7s. 1d.; D. S. D. Co., electric cars, £645 13s. 6d.; total £3,722 0s. 7d.; corresponding week last year—D. U. T. Co., electric cars, £2,778 3s. 11d.; ditto, horse cars, £47 11s. 5d.; D. S. D. Co., electric cars, £565 6s. 9d.; total, £3,391 1s. 6d.; increase, £330 19s. 1d.; aggregate to date, £43,863 15s. 2d.; aggregate to date last year, £40,305 15s. 9d.; increase, £3,560 19s. 5d. The mileage worked is 45 miles electrically, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year.

Glasgow Corporation Tramways.—Receipts for week ending March 16th, 1901, £8,500 17s. 6d., as compared with £8,356 7s. 2d. for same period last year.

Liverpool Overhead Railway.—The receipts for the week ending March 24th were £1,475; corresponding week last year, £1,219; increase, £256. Total to date, £17,744; corresponding period last year, £16,860; increase, £884. Miles open, 6 miles 67 chains.

STOCKS AND SHARES.

Wednesday Evening.

There has been little during the past week to encourage investors to enter Stock Exchange markets, and the general trend of the prices given on the ensuing pages is downward, like that of gilt-edged and heavy securities in other departments. The flatness of Consols, which has resulted in the price dipping lower than it has been for nine years, is naturally affecting the financial situation, and the monied world will sigh with relief when the Budget is presented on April 18th next, after which brighter times may be expected, since the worst about the coming Loan will then be known.

It is interesting to record that Stock Exchange gossip talks of an issue of 50 million Consols at a minimum price of 94. The suggested quotation looks ridiculously low, but fresh emissions nowadays have to be made at tempting figures; the public is still coy. We hear that there is every likelihood of a new Debenture issue by the Charing Cross Electric Supply Company. No details have so far transpired, but we shall not be absolutely amazed to hear that it will assume the shape of a 4 per cent. Debenture stock offered at par to existing shareholders. The shares are unchanged on the week. City of Londons are dull; so are Metropolitans. The cause for the drop in the latter is the eternal Marylebone situation. This time the market is looking apprehensively at the action of the local authorities in approaching Parliament for further powers.

Brompton and Kensington are in good demand, and the price shows a slight narrowing in the right direction. Kensingtons have also improved. The increased dividend and the fact that the shares pay an investor better than any other of the same description (to which our last week's table drew attention) are securing support for the company's shares. South London Electrics are 3, although the report is considered bad. Westminsters have receded 10s. on a few sales. The new shares are now identical in every respect with the old, but some stupid redtapism on the part of the Stock Exchange officials has, up to the present, denied the quotation of the two classes in a single line. Consequently the dealers are declining to furnish the Official List with any price at all for the new shares. Woolwich Electrics, for long time practically dormant, have come to the front this week, and are now 1¼. No doubt the capital report has brought in the recent buyers of the shares.

Electric Constructions have not regained their drop of a week ago, although the idea that the company had made a serious loss over one concern is now known to have been a mare's nest. In the same section Edison & Swan 4 per cent. Debenture stock is down a point, following the declension in the price of the Preference last week, and of the Ordinary a fortnight since. Willans & Robinson maintain their position at 12, despite the proposed raising of the share capital from half a million to £750,000. The company's report speaks of growing business, and shareholders will not complain at being presented with a bonus of 2 per cent. over and above the dividend at the rate of 10 per cent. per annum. British Westinghouse Preference, as a speculative investment, appear to deserve some attention. They are entitled to a 6 per cent. dividend, and the price of the £5 fully paid shares is 4⅜. The works, it is stated, are being equipped with all the most modern machinery.

Marconi's shares are being dragged forth to the light of day again, the market this time having broken out in the Kaffir Circus. The closing price to-night is 3 5/16, and the business, of course, is largely professional. Telegraph Construction shares are down a £1, but Manufacturing have not moved. Movements in this department are generally towards lower values. British Aluminiums at 8 are 10s. off, and India-Rubber Debenture stock is a point lower. The appearance of a possible seller is quite sufficient for prices to be marked down in the less negotiable securities, so touchy are the times.

Globe Telegraph shares are unaffected at the announcement of the usual 2s. 6d. interim dividend, and Submarine Cables Trust Certificates continue at 126½. The Telegraph market is almost lifeless, and there is not a single quotable change in its price list. The Chinese crisis still keeps Eastern Ordinary stock dull, but the slight decline of last week has gone no further; Eastern Extensions are still 14.

Central Londons are hard, the Ordinary remaining at £9. The agitation now proceeding in certain quarters for the appointment of an investigatory Committee is coldly regarded in Capel Court. The directors are fully capable of managing the company by themselves, according to Stock Exchange views. Waterloo and City stock is up a point. British Electric Tractions are good, but the Preference have lost the £1 a share advance registered last week. London United Tramways Debentures are 3 premium.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation March 20th.	Closing Quotations March 27th.	Business done during week ended March 27th, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	55 — 65	55 — 65	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	50 — 53	50 — 53	50	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	94 — 96	94 — 96	95½	94
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	8 — 8½	8 — 8½	8	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3½	3 — 3½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	7½— 8½	7½— 8½	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	16½	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	9¾	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 — 104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	3 %	9⅜— 10¼	9⅜— 10¼	10	...
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	143 —148	143 —148	145⅜	143½
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	93 — 96	93 — 96	93	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —117	113 —117	114⅜	114
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	14½— 14⅝	14½— 14⅝	14 11/16	14⅜
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) ...	10	...	...	...	13¾— 14¼	13¾— 14¼	13¾	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	111 —116	111 —116	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	101	100½
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	9⅜— 10¼	9⅜— 10¼	10	9⅜
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14⅜— 15½	14⅜— 15½	15⅛	14 13/16
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	32 — 34	32 — 34	...	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ⅛	¼— ⅛	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	⅜— ½	⅜— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅛— 3⅜	3⅛— 3⅜	3 3/16	3⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	10 — 12	10 — 12	10½	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅛— 4⅜	4⅜— 4⅝	4 9/16	4⅜
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	92 — 95	90 — 93	92	90
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	97 —100	97 —100	97	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4½— 5	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	97 —100	97 —100	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	..	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14¼	13⅜— 14¼	13⅞	...
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	8%	...	⅝— ⅞	⅝— ⅞	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	6⅝	6½
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7 — 8	7⅜— 8¼	8	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8 — 9	8¼— 8¾	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10 xd	9 — 10	9⅝	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅝	5¼— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5⅜— 6¼	5⅜— 6¼	6¼	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	7½— 8½	7 — 8	8⅛	7¼
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13 — 14	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	121 —126	122¼	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	4 %	8 — 9	8 — 9	8⅝	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4¾— 5¼	4¾— 5¼	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	3 — 4	3 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	12½— 13½	12 — 13	12⅝	...
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	97 —100	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	13½— 14½	13½— 14½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	12 — 13	11½— 12½	12⅛	...

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Mar. 20th.	Closing Quotation Mar. 27th.	Business done week ended Mar. 27th, 1901. Highest	Lowest
20,000	British Aluminium 7 % Cum. Pref.	‡ £10	...	...	...	8 — 9	7½— 8½	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	£10	6 %	...	...	15 — 16	15 — 16	15½	15⅜
50,000	Do. do. 6 % Cum. Pref.	£10	...	...	...	12½— 13½	11½— 12½	12 1/16	...
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	122	121¾
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/16— 3/16	1/16— 3/16	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	1/16— 1/8	3/16— 1/8	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	85 — 90	85 — 90	...	...
70,000	British Insulated Wire Ord.	£5	15 %	20 %	15 %	10 — 11 xd	10 — 11	10¼	10 3/16
70,000	Do. do. 6 % Cum. Pref.	£5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	£2	5 %	6 %	...	1⅝— 1⅞	1⅝— 1⅞	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	£2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	2 3/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	103 —108	107½	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	£5	15 %	15 %	...	15 — 16	15 — 16	...	...
40,000	Do. do. 5 % Cum. Pref.	£5	...	...	...	5½— 6	5½— 6	5⅝	5⅝
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	£10	...	...	...	8⅞— 9¼	8⅞— 9¼	9 1/16	9
78,703	Do. do. Pref. half-shares	£5	...	...	...	4⅝— 5¼	4⅝— 5¼	...	...
78,703	Do. do. Def. do.	£5	...	...	...	4 — 4½	4 — 4½	...	...
855,000	City and South London Railway	Stock	2½%	1⅝%	1½%	46 — 50	46 — 50	46	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	£10	...	...	...	4 — 5	4 — 5	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	£3	6 %	7½%	...	3¼— 3⅜	3¼— 3⅜	3 1/16	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	£5	6 %	6 %	...	1½— 2	1½— 2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	£5	6 %	6 %	...	3 — 4	3 — 4	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	£100	...	...	...	88 — 90	87 — 89	88½	88
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	£100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	£2	6 %	6 %	...	1⅝— 2¼	1⅝— 2¼	1⅝	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	£2	7 %	...	...	2½— 3	2½— 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	£10	7 %	7 %	...	10 — 11	10 — 11	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	£5	14 %	15 %	20 %	15 — 16	15 — 16	15⅞	...
35,000	Do. do. do. 4½ % Pref.	£5	7 %	...	...	5½— 6	5½— 6	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	107 —111	107 —111	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	£10	10 %	10 %	...	21 — 22	21 — 22	21 1/16	21
300,000	Do. do. do. 4 % 1st Mort. Deb	£100	...	...	...	102 —105	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	£10	3½%	3¾%	3½%	7⅞ — 7⅞	7⅞— 7⅞	...	...
10,000	† Do. do. Pref., £10 paid	£10	5 %	5	...	13 — 13½	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	£12	15 %	15 %	17½%	38 — 42	37 — 41	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	£100	...	... %	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	£5	8 %	12 %	...	11 — 12	11 — 12	11½	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	£5	...	...	...	5½— 6	5½— 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	£100	3 %	3 %	3 %	93 — 96	94 — 97	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, 3/8—1/8.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—11.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11—12; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7 Debentures, 102—104. Dividend, 1900, on Ordinary Shares 12 %.
*T. Parker, £10 (fully paid), 16½.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (February 21st, 1901).

MARKET QUOTATIONS, Wednesday, March 27th.

CHEMICALS, &c.	This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. per cwt.	80/-	80/-	..
a Ammonia, Muriate (crystal) .. per ton	£33 10	£33 10	..
a „ „ .. per ton	£30	£30	..
a Bleaching powder .. .. per ton	£7	£7	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£17 10	£17 10	..
a Bensole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90%) .. .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. per ton	£25	£25	..
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a „ White Sugar .. .. per ton	£31	£31	..
a „ „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C). per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¼d.	3¼d.	..
a „ Caustic (75/80%) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	64/-	64/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6 5s.	..
a „ Recovered .. .. per ton	£5 10	£5 10	..
a „ Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£10 15	£10 15	..
a „ Crystals .. .. .. per ton	£3	£3	..
„ Bichromate, casks .. per lb.	2¾d.	2¾d.	..
METALS, &c.			
b Aluminium Wire, in ton lots.. per ton	£224	£224	..
b „ Sheet, in ton lots per ton	£191	£191	..
p Babbitt's metal ingots.. .. per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2" to 12") basis per lb.	7½d.	7½d.	..
c „ Tube (brazed) .. .. per lb.	10d.	10d.	..
c „ „ (solid drawn) .. per lb.	8½d.	8½d.	..
c „ Wire, basis .. .. per lb.	8d.	8d.	..
c Copper Tubes (brazed) .. per lb.	11d.	11d.	..
c „ „ (solid drawn) .. per lb.	10½d.	10½d.	..
g Copper Bars (best selected) .. per ton	£84 10	£84	10s. inc.

METALS, &c. *(continued.)*	This week.	Last week.	Inc. or Dec.
g Copper Sheet .. .. .. per ton	£84 10	£84	10s. inc.
g „ Rod .. .. .. per ton	£84 10	£84	10s. inc.
e „ (Electrolytic) Bars .. per ton	£82	£82	..
e „ „ Sheets .. per ton	£90	£90	..
e „ „ Rod .. per ton	£84	£84	..
e „ „ H.C. Wire per lb.	9¼d.	9¼d.	¼d. dec.
f Ebonite Rod .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha fine .. .. per lb.	8/-	6/-	..
h India-rubber, Para fine .. .. per lb.	3/6½ to 3/7	3/6½ to 3/7	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) .. per ton	45/6	45/10½	4½d. dec.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. .. per ton	70/- to 72/6	70/- to 72/6	..
i „ Wire, galvanised No. 8 .. per ton	£10	£10	..
g Lead, English Ingot .. .. per ton	£13 12 6 to £13 15	£13 to £13 2 6	12s. 6d. inc.
g „ „ Sheet .. .. per ton	£15	£17 15	£2 15s. dec
m Manganin Wire No. 26 .. .. per lb.	8/-	8/-	..
g Mercury .. .. per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small .. per lb.	3d. to 9d.	3d. to 9d.	..
d „ „ „ medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large .. per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p „ rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ „ strip & sheet per lb.	From 1/3	From 1/3	..
o Platinum .. .. per oz.	£4	£4	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/1½	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n per ton	From £15	to £40	..
i „ „ in bars	£58	£58	..
g Tin, block .. .. per ton	£119 to £121	£118 10 to £119 10	inc.
g „ foil .. .. per lb.	1/9	1/6	3d. inc.
n „ wire, Nos. 1 to 16 .. .. per lb.	1/9	1/9	..
p White Anti-friction Metals —			
"White Ant" brand .. .. per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's per lb.	9d.	9d.	..
j „ Best Flax, 6 lbs. .. .. per lb.	6d.	6d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	4½d.	4½d.	..
j „ „ Russian, 10 lbs. .. per lb.	5½d.	5½d.	..
j „ Jute, 180 lbs. rove .. per ton	£14	£14	..
k Zinc, Sh't. (Vielle Montagne bnd.) per ton	£21	£21	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yoe & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.

By A. C. Eborall, Member.

(Abstract of paper read on Thursday, March 14th, 1901.)

Polyphase systems of generation and transmission, combined with direct current distribution from sub-stations, are very much in evidence at the present time, in connection with many large lighting and traction schemes, and there is little doubt but that the use of such combined systems will greatly extend in the future. The author does not profess to put forward anything new, but merely to bring up for discussion some working notes on the subject. It is always to be understood that the author has in mind the case in which very large amounts of power, transmitted at high pressures, have to be handled—the modern case, in fact. Moreover, on account of their greater commercial importance, three-phase systems are more particularly considered.

Considering the general case, applicable to large towns, the polyphase current will usually arrive at the sub-stations in the supply area at a pressure between 5,000 and 10,000 volts between lines; the work to be done comprises the conversion of the whole of the current in question into direct current at 2 × 220 volts for lighting, or 500 to 550 volts for traction, together with the provision of means for regulating the current and feeding it into the low pressure networks comprised in the area. The size of the units in the sub-stations will vary in general between 300 and 1,000 kw. output.

(*a*) Asynchronous motor-generator equipment.

This type of sub-station equipment consists in the employment of a number of polyphase induction motors driving an equivalent number of direct current generators; the motor-generator units will be of such a size that the high-pressure current can be led directly into the motors, and consequently the equipment and operation of the sub-station will be of the simplest possible character. No starting gear has to be provided beyond a simple rotor resistance for each motor, there is no synchronising to be done, and the regulation on the direct current side is made on the fields of the generators, either by hand or by compound windings in the usual way.

The construction of such motors lends itself so well to high insulation of the stator that motors as small as 150 h.p. can be perfectly satisfactorily (and cheaply) built for pressures of 5,000—6,000 volts. With large units it does not pay to employ step-down transformers, at any rate up to 10,000 volts. If the motors are less than about 500 h.p. individual output, and the pressure greater than this figure, it may pay to employ transformers, because the amount of slot insulation required will probably be found to be excessive, necessitating the employment of motors of large dimensions compared with their output.

With the high pressure current led directly into the motors, the best arrangement for the sub-station will usually consist in employing starting switch pillars for the motors, the direct current board being away against a wall. The rotor resistance and stator starting switch should be interlocked, and thus the starting up of each set is performed by one movement of a hand wheel. The employment of a starting switch pillar adjacent to the motor possesses the great advantage of reducing the length of the heavy rotor cables to a minimum (an important point).

It is standard practice nowadays to build all induction motors of large size (having wound rotors and slip rings), with an arrangement for short-circuiting the rings and lifting up the brushes after the motor has attained full speed. It is perfectly possible to start up the sets from the direct current side, but in general this is not so convenient.

(*b*) Synchronous motor-generator equipment.

With this equipment, synchronous polyphase motors operated at the line pressure take the place of the induction motors referred to above; conforming with standard practice, the synchronous motors would be of the revolving field type. A sub-station with such an equipment will not be quite so simple as the foregoing, on account of the necessity for synchronising the motors before switching them in, because the starting arrangements are more elaborate, and also because the synchronous motors are not self-exciting. The performance of synchronous motors depends so much upon the field adjustment (see later remarks), that a well-designed field regulator for each motor is a necessity.

The starting of the motor-generator sets may be effected in several ways. By far the best way is to start them from the direct-current side; as soon as the first machine is running all the others can be started from it, but it is always necessary to provide means for starting up any motor-generator in the sub-station from the alternating-current side. One of the best possible arrangements is to provide an auxiliary (asynchronous) motor-generator which can be used for exciting and starting the main units when required; this auxiliary set would be shut down as soon as one or more of the main units is in operation, direct current then being available at the bus-bars. If the low-pressure network is arranged to be partly fed, or balanced, by accumulators, the starting and exciting would naturally be effected initially from these; this is, however, not the general case.

The operation of switching-in a synchronous motor-generator started in this way is of course very simple. The set being brought up to approximately synchronous speed and excited to the right value, the correct speed (as indicated by the synchronising lamps) is attained by regulating the fields of the direct-current machine now running as a shunt-motor with all main resistance out. At the right moment, the main high-pressure switch is closed, and after this the direct-current main resistance perhaps short-circuited. Finally, the fields of both motor and generator are adjusted, the latter in order to take up the load, and the former in order to regulate the idle current of the synchronous motor.

Assuming that no direct current is available, the next best method of starting up the motor-generator sets, together with their direct-coupled exciters, is by means of starting motors. On a bracket at that side of the motor-generator remote from the exciter, an induction motor is placed, the rotor being mounted directly upon the extended shaft; this motor would be fed from a step-down transformer and would have a capacity of about 10 per cent. of the full load output of the main unit. The number of poles on the starting motor would be fewer than the number of field poles on the synchronous motor, being such that it can bring up the set to a speed somewhat higher than that corresponding to synchronism, in spite of the load on it due to the iron losses and excitation of the main unit, and the friction and ventilation losses of the combination. Moreover, the starting torque of this auxiliary motor must be high, it being preferably attained by the employment of a non-inductive rotor resistance; this latter is also of value when synchronising, although not absolutely necessary.

To start up then, all that has to be done is, firstly, to speed up the combination by switching in the starting motor, and cutting out the rotor resistance until the combination is at maximum speed: secondly, close the field circuit of the synchronous motor, and regulate the exciting current to get the correct pressure; thirdly, reduce the speed by slowly adjusting the rotor resistance, until the synchronising lamps indicate exact synchronism; then switch the synchronous motor on the line, and afterwards cut out the starting motor and adjust both field systems as before.

If the starting motor is constructed with a permanently short-circuited rotor, the third operation above will consist in switching out the starting motor altogether, as soon as the correct value of field current has been attained. The speed of the combination will immediately drop, and the main switches must be closed as the speed passes synchronism. The synchronous motors will pull themselves into step without doing any harm, but careful adjustment is always advisable.

The third method of starting up a synchronous combination is dealt with below, in connection with rotary converters.

Apart from the question of power-factor, the running performance of synchronous motor-generators is very similar to that of asynchronous machines, and they are equally reliable.

(*c*) Rotary converter equipment.

Sub-stations equipped with rotary converters are of a far more complicated character than either of the types previously discussed. Although the rotary converter possesses characteristics similar to those of the synchronous motor, and also to those of the direct current machine, it possesses in addition a number of special features having a large influence on its performance, the result being that even when such machines are working under the very best conditions, they cannot compare, with regard to simplicity of operation, with either asynchronous or synchronous motor-generators.

The first point to be noted is that the rotaries require to be operated at low pressure. The pressure between any two slip rings, whatever the nature of the armature winding, is always a definite percentage of that on the direct current side with a given pole-width, being about 61 per cent. for three-phase and about 71 per cent. for two-phase rotaries,*—consequently step-down transformers have always to be inserted between the slip rings of the converters and the high pressure feeders. For the large units under consideration, separate transformers are always used for each phase of the transmission line; but for small three-phase or six-phase rotaries (up to about 100 kw. capacity) it is always preferable to use three-phase transformers, for, owing to their common magnetic circuit, possible pressure variation beween the phases of the three-phase transmission becomes reduced in amount, as such transformers form excellent balancers.

In two-phase work there will be two transformers per rotary; in three-phase or six-phase work there will be three. As a rule, the best arrangement of the three transformers will be to connect them up in a "mesh," on both high and low pressure sides. This is principally because in the event of one transformer developing a fault and blowing its fuse, the supply need not be interrupted for a moment, for the remaining two will continue to supply a three-phase current to all three phases of the rotary; the reactions in the latter tend to keep the arrangement symmetrical and the phases equally balanced. Under these circumstances the rotary can be kept fully loaded over the period of emergency, if not too long. If the transformers had been "star" connected, single-phase current would be delivered under the same circumstances, and the rotary would have to be immediately cut out on account of the heavy sparking that would occur at the commutator; the machine would not be able to carry anything like its full load over the period of emergency, and the system would be thrown greatly out of balance. Another advantage (of secondary importance) with mesh-connected transformers is that the secondaries are cheaper to wind, because the area of the copper in the winding is 58 per cent. of the copper area for the corresponding "star"-connected transformer.

One advantage of the star connection lies in the fact that the space taken up by the primary winding of each transformer is

* These are the no-load values—when the machine is loaded they are naturally departed from to a small extent, on account of the armature drop. Moreover, if the impressed pressure-wave is not sinusoidal, the values given will be departed from.

somewhat less in comparison, because the pressure across each transformer is only 58 per cent. of the full line pressure, and hence winding space is saved on account of the reduction in the insulation. This is, of course, an advantage, especially when dealing with pressures of the order of 10,000 volts, but, in the author's

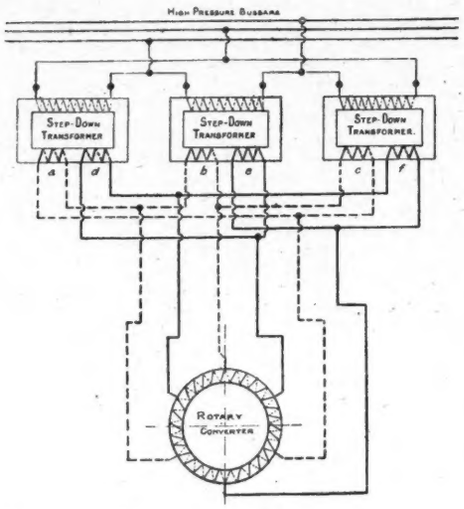


Fig. 1.—Six-Phase Mesh Connection for Rotary Converters.

opinion, it is one not to be compared with the safeguard against total breakdown afforded by the mesh connection.

Exactly the same arguments apply to the six-phase case, in which the secondaries of the transformers are arranged with either a double mesh or a double star connection, but preferably the former, as indicated diagrammatically in fig. 1.

It will be seen that this connection makes use of two distinct mesh connections, one superposed upon the other, the two meshes being in electrical connection through the armature windings of the converter. It is obtained from three single-phase transformers, similar in all respects, each being wound with two equal secondary windings.

The three secondary windings, *a*, *b*, *c*, are mesh connected, and led to three slip-rings in connection with the armature winding of the rotary at points 120° (electrical) apart, while the three secondaries, *d*, *e* and *f*, are also mesh connected, but in the opposite direction; the three conductors from the points of this mesh are taken to the remaining three slip-rings on the shaft of the rotary, which are in connection with points on the armature winding lying midway between the tappings to the three slip-rings first mentioned. A little consideration will show that, under these circumstances, the two meshes differ half a cycle (180°) from one another, and consequently satisfy the six-phase condition.

While the six-phase connection for rotary converters is more complicated and somewhat more expensive than the three-phase, yet it will undoubtedly pay to use it. Steinmetz and Kapp long ago pointed out that the output of any given rotary can be increased 40—50 per cent. by its use—that is to say, for the same mean heating of the armature coils, a six-phase rotary has an output 40—50 per cent. greater than the three-phase rotary, according to the value of the power factor of the alternating current side. As the output of any well-designed rotary converter is determined solely by the permissible temperature rise (there being no distortion of the field flux under usual working conditions—power factor approximately unity), this increased output is a great practical advantage. Another advantage of the six-phase connection with otary converters is that the heating of the armature is much more runiform, as it is well known that, in two and three-phase rotaries, those portions of the armature winding on each side of the tappings to the slip-rings heat up considerably more than the remaining portions of the winding.

On account of the fact that all rotary converters have to be fed from step-down transformers, the switch gear becomes more expensive, for it is good practice to provide switches in the secondary circuits of the transformers. Such switches are absolutely necessary, for two-phase rotaries arranged for starting from the direct-current side; in this case, unless the transformer secondaries are open, they become short-circuited (at the moment of starting) upon the armature winding, causing a great increase in starting current, and violent sparking at the commutator, until the machine is well towards full speed. The heavy switches in the secondary circuits are best mounted upon, or close to the transformers, which latter should be close up to the rotaries, in order to reduce to a minimum the pressure drop, losses, and cost, of the heavy conductors.

When two or more rotaries are not arranged to be fed (for any special reason) from separate groups of transformers on the alternating-current side, and they are connected to a three-wire network on the direct-current side, it is necessary to wind each unit forming the group of transformers with a multiple secondary winding, as described above, the arrangement being as shown in fig. 2, illustrating the connections for two machines. That is to say, it is impossible to operate a number of rotaries feeding a three-wire network from common bus bars on the alternating-current side. The reason is readily apparent from the figure—the slip ring sides

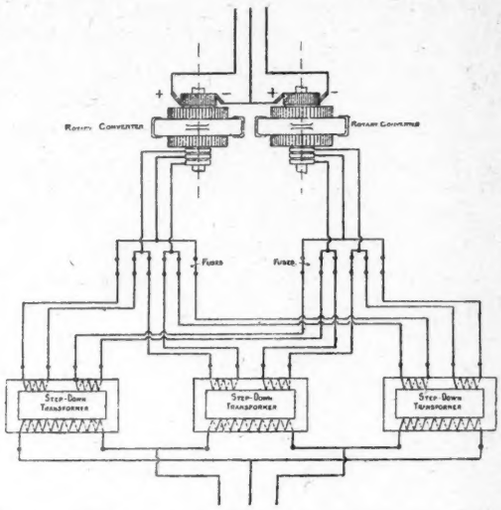


Fig. 2.—Connections for Rotary Converters in Parallel Feeding Three-Wire System.

of the machines cannot be *directly* paralleled, owing to the connection already existing on the direct current side—if they were directly joined a disastrous short circuit would naturally result. It may be noted in passing that the arrangement of the fuses in the secondary circuits of the transformers shown in this figure* (each conductor coming from a slip ring is fused twice) is a good one, for if one transformer gives out, the service will not be interrupted, for the reason already given above.

There is, however, a certain advantage in using *star-connected* transformers for converters feeding three-wire systems, for by the adoption of this form of connection better balancing can be attained; the secondary neutral points of each group of transformers may be profitably connected to the middle wire, which latter may or may not be earthed. Under these circumstances each rotary would be fed from a separate group of transformers.

The next question is that of pressure regulation. With motor-generators this question hardly comes in, for, as already indicated, the regulation is performed wholly on direct-current machines of standard design, either automatically or by hand, in the simplest possible manner. With rotary converters the pressure on either side is practically totally independent of the field strength (although not of the field configuration), and consequently the direct-current pressure cannot be varied by regulation on the fields alone.

(To be continued.)

WHY NOT CYLINDRICAL BOILERS?

Our contemporary, *Engineering*, which has backed the Admiralty through thick and thin, and advocated not merely the water-tube boiler, but the Belleville type, has had to say something on the interim report of the Boiler Commission, and says it in such a very funny way indeed that it reminds one of a snail in a hurry to move, and yet constantly drawing in its horns at the fear of its own movements. Vexed, doubtless, at the utter rout of its pet and *protégé*, *Engineering* now declares that "only foolishness or ignorance, or worse, would recommend cylindrical boilers for the Navy to-day." Personally, we would prefer to be bracketed with Admiral Melville, of the U.S. Navy, who *has* gone back to the cylinder boiler, than with the Solon who has been backing up the Belleville so many years in the columns of our contemporary. A writer speaks of *Engineering* as having been sitting on the fence for several years. We cannot even award this praise, for, to our mind, *Engineering* has been fairly over on the Admiralty side of the fence, and has so little appreciated the facts of the lamented Belleville, that it did not even have the prescience to sit *on* the fence. Neither did the *Engineer*, but the *Engineer* finally became alive to facts, and promptly changed its attitude. Now

* This arrangement of fuses for such a case originated with the General Electric Company (U.S.A.).

why is it that the cylinder boiler should not be suitable for the Navy? It has proved itself most suitable for the best and fastest merchant steamers. There are grave doubts if the water-tube boiler weighs less than the cylinder boiler. Certainly if coal be added to the weight of boilers and accessories in each case, the cylinder boiler will come out well ahead. A writer in the *Pall Mall Gazette* says that the Admiralty never got satisfactorily more than 17 H.P. per foot of grate, and then only for three or four hours, and at the cost of a ruined boiler, whereas the mercantile boiler in over 1,100 of our finest merchant steamers easily develops 17 H.P. per foot of grate for a week or several weeks on end. It would appear that the Admiralty first put entirely unsuitable cylinder boilers of bad design into a ship and then proceed to demonstrate their bad design. The ruined boilers are then dug out through the decks, and the Admiralty exclaim, "See the expense of these shell boilers," and they have gone on this way for years, as though a *Lucania*, or *Teutonic*, or *Britannic* did not exist. It looks like pure and unmistakable ignorance on the part of someone. Doubtless it is expensive to be always tearing the decks, but it may well be doubted if any such frequent need really exists. We certainly see no good reason for the cylinder boiler of proper design being rejected. Indeed, we doubt if the well-designed cylinder boiler has ever been rejected, for it has not been employed. The Howden system of forced draught is demanded by one writer in the *Pall Mall*. No doubt, with a good boiler, the Howden system is excellent, as proved in so many large merchant ships, and it is known everywhere except in the Navy. We wish to say nothing more about Bellevilles, but we do wish to keep open the fact that it is dying hard, that the anxiety of the Committee to issue a face-saving report appears to have emboldened the Admiralty to claim that it is by no means so bad a boiler after all. They have done this through their apologist in the House in face of the most damning evidence of repeated failures.

The finding of the satisfactory water-tube boiler may be a matter of months or years, but in the meantime there must be some boiler employed, and that quickly, and there is every reason to demand that this should be the cylindrical boiler. One thing is certain: if the Belleville boiler is not so bad as it is painted, the country will be quite safe with a very ordinary cylinder boiler, and we trust such counsels will prevail as may lead, and that quickly, to the use of a genuine mercantile marine boiler in our helpless Navy until such time as a really good water-tube boiler has been discovered to beat it in safety, economy and durability.

Assuming the satisfactory water-tube boiler, its special and particular advantage lies in the rapidity with which steam may be got up. The getting up of steam in cylinder boilers is a slow business, because the top of the boiler gets hot before the bottom, and severe stresses are thus set up, and tubes are apt to leak, and so on. Circulation twill not establish itself readily until the boiler becomes really hot, and even then we have seen the bottom of a boiler cold with steam pressure above. The obvious remedy is, of course, some kind of forced circulation. It is assumed that there is always one boiler kept under steam, and some engineers recommend the use of a species of injector fed with steam from the auxiliary boiler or other source, and arranged, we believe, to draw off the upper water in the boiler and deliver it into the boiler bottom. The use of a small centrifugal pump has been suggested, to draw its supply from the boiler bottom, and deliver it at the water level. In a cylindrical boiler, 12 ft. diameter and 16 ft. long, there will be perhaps 3,000 gallons of water more or less, according to the class of boiler, so that a small 2-in. centrifugal pump would move the whole of that water every hour, and would do so with but little expense of power, for the pump would work against no resistance, but would merely keep the water moving. There seems good reason to believe that by this means a boiler may be started as quickly as the fires can make it hot, and without injurious effects. Such a boiler as the above, with, say, 60 square feet of grate surface, would burn coal at the rate of, say, 20 lbs. per square foot of grate, and would evaporate at least 8 lbs. of water per pound of coal, which is equivalent to 9½ million heat units. To raise the whole 3,000 gallons of water in a cold boiler through 200°, would only absorb 6 million heat units, and it should be possible to get a boiler up to some steam pressure in an hour after fires are well burning. It ought to be at least considered worth while making an experiment on a cylinder boiler fitted with a water circulator and forced draught of the Howden type or the induced type, with a view to ascertain in what time steam can be got up, and if the difficulties of quick steam raising really do exist other than in lack of circulation. In practice when an engineer wishes to get his boilers warmed evenly he blows them out, so as to draw down the heated water to the bottom, and feeds up at the top. With circulator pumps the water passed through the pump would be made to absorb the waste heat of the engines driving the pumps, so that little heat would be lost. If trials show that steam can be raised quickly there is an end of the deplored slowness of the cylinder boiler. We must be prepared for emergencies by having sufficient steam up in some boilers to speedily get it up in others. This keeping up of steam would be less costly of coal than the policy of retaining such an uneconomical boiler as the Belleville. Considering the condemnation of this boiler by the Committee, we protest against the tone of Mr. Arnold Foster's speech in the House, which was practically a denial of the Committee's finding.

Maesteg.—The D.C. has resolved to obtain expert advice upon the cost of lighting the streets by electricity.

ANNUAL MEETING OF THE ASSOCIATED CHAMBERS OF COMMERCE.

At this meeting held in London on the 14th inst., Sir Edward Sassoon (Liverpool) moved the following resolutions: (1) "That whilst expressing satisfaction that after numerous delays the negotiations connected with the formation of an all-British Pacific Cable have progressed sufficiently to enable a contract for laying the same to be entered into, this association would strongly urge on his Majesty's Government the absolute necessity that exists, both on account of the defence of the Empire and the promotion of its commerce, that immediate efforts should be made and actively continued until all parts of the Empire, whether Colonies or Dependencies, have lines of telegraphic communication with each other as well as with the Mother Country without such lines passing through any foreign country or possessions. (2) That every reasonable support be given by this association to the Imperial Telegraph Committee of the House of Commons in their efforts to promote inquiry: (*a*) into the questions of telegraphic communication between the different parts of the Empire, and the charges for the same, with a view to increased efficiency and economy in the telegraph service for commercial purposes; and (*b*) into the cable arrangements for Imperial defence."

In view of the limited time at the disposal of speakers, I shall endeavour to sum up very briefly the considerations which, in the judgment of the Cable Committee of Members of the House of Commons, appear to call for your favourable, and, I hope, your unanimous decision upon this resolution.

Since I had the honour of addressing this Chamber a year ago, a good many things have happened. There was a full debate in the House of Commons on May 22nd, in which both the front benches took a useful, and I may add, a sympathetic part. The general trend and purport of this debate went to show that some radical modifications of the system upon which our cable communications are conducted could with great advantage be introduced. We succeeded in obtaining the appointment of a Departmental Committee. This Committee has now fairly commenced its labours.

I have been cross-examined by them at some length in the course of my evidence. I take it that it would perhaps constitute some breach of etiquette were I to disclose the various schemes and recommendations laid before them then, until after the Committee had completed its work and had declared its finding.

I am not without the hope and the belief that their report will appear before the termination of the present Session of Parliament. The public will then be in a position to form an estimate of the views, for and against, the revision of the present system in the light of the evidence and with the assistance of the report of the Committee. You will, therefore, notice that the wording of the resolution is couched in general terms, but it is none the less important that the hands of those who are aiming at bringing about reform should be strengthened by the continued attention to, and discussion of, these matters by such a representative body as I see before me.

In my speech in the House asking for a Committee, I went very fully into most of the factors surrounding the position of cable communication, as far as I was enabled to do from the data and information which as a private member I had succeeded in gathering. The cable companies published a pamphlet with the object of rebutting the charges that were made against their system. To those replies I had the opportunity, afforded by the meeting of the Associated Chambers of the Empire on June 29th last, of making categorical, and I hope effective, rejoinders. I shall not trouble you, therefore, with the views that I then advanced, because they were very fully reported in the leading journals, and also because no refutation from the companies has ever appeared against them to my knowledge.

Now what is the present position? It is this. That the work of providing a rapid and uninterrupted intercourse between the Mother country and her numerous over-sea possessions is entirely in the hands of private enterprise, subject to no effective control by the State, either in respect of the efficient maintenance of these lines of communication, or of any well defined limits to the charges which they levy, although drawing handsome subsidies from various Governments. Well, I think you will agree that this is an unsatisfactory situation. Whatever the convenience or expediency there may have been in times past, of entrusting to private agencies a public service of such magnitude as this, the Imperial character of the relations that now exist, the predominating desire on the part of our great commonwealths that those relations should be further cemented and accentuated, would seem to show that the management by private companies of one of the most important factors in the scheme of the defences of the Empire, which also enables our business communities to hold their own in face of the strenuous rivalry of foreign competitors is an anachronism, and a mistaken policy.

What is the business of Cable Companies? Why, first and foremost, in their fiduciary character to their shareholders, the directors have to place in the forefront of their administration the exigencies of a prosperous balance-sheet; 7, 8, 9, 10, 12, and even 20 per cent. have been paid; in fact, an unlimited scale of progression in dividends must be their first aim and object. They have most successfully attained that object. The public wanted the service, and they had to pay for it. But how long are we going to remain content with paying three or four times over for a service of universal necessity to our Empire, when the State is bound to, and certainly can, very easily provide, if not a better service, one at least quite as good with, say, 3 per cent. as a basis of return. The

subject of an efficient State control, with the ultimate expropriation of the private cables being kept steadily in view—that subject is rapidly coming to the front, for, after all, business cannot be conducted on purely philanthropic principles, especially when our love for our fellow man simply means, in the case before us, that we are called upon to make additions to a purse which is already plethoric.

Within the last two or three years the subject of State control may be said to have made giant strides. The deplorable want of knowledge that formerly existed in the public mind made us feel that we were almost helpless in the matter, and all we had to do was to grin and bear it.

It is obvious that, having been denied all opportunity of analysis, there are many difficulties in the way of thorough criticism; but these opportunities, scanty as they are, have encouraged us, and looking to the results already achieved, amply justify us in making further efforts for a thorough and comprehensive reform.

One of the arguments advanced in favour of the *status quo*, and which, after all, is only a challenge to those who ask for improvement, is that private companies are much better able to obtain concessions from foreign Governments than can the State. I traverse that argument. In the first place, a great part of the negotiations leading up to many of these concessions has received active support from our own diplomatic officers. What is meant, I presume, is that private companies are better able to grease the wheels by the application of methods frequently attributed to Oriental diplomacy. If that be so, I will not do our Foreign Office the injustice to believe that its resources would not be found fully capable of legitimately bringing matters of such general public interest to a suitable issue when necessary. What other argument illustrating the advantages of private *versus* State cables can be adduced? I know of none; whereas I can see plenty of disadvantages. I will only enter into some of them. The most striking disadvantage is the fact that within the whole course of the history and the life of these cable companies they have apparently not thought it consistent with their duty to their shareholders to establish any cable between the Mother Country and the Colonies which does not possess two grave inconveniences. The first is that the cables all touch on foreign territory, some of them friendly, and I hope likely to remain so, but we cannot always depend on this; the second is, that the cables pass through shallow waters, and the vulnerability has been abundantly proved over and over again. I therefore repeat that if you wish to see our defences placed altogether, as far as it is humanly possible to do so, out of reach of hostile intervention; if you wish to add greater mobility to our cruisers and to our men-of-war, to afford increased security to our coaling stations and to our ports of arms in time of war, and to give our commerce all the advantage of modern improvements, you must gradually, and as far as possible, abandon the obsolete policy of landing your cable ends on strange shores, a policy which is not only unwise from a national point of view, but which may also inflict an unfair burden on a friendly State should we ever, unfortunately, become engaged in an European war. Further, if you wish that the unparalleled facilities given by foreign Governments to the members of commercial and industrial communities be extended to you by our own Government; and surely we are sufficiently handicapped already by our backward system of commercial education; then you must agitate and never cease in earnest insistence until you have rubbed this economical necessity well into the minds and the consciences of our governing body. All these reasons which militated in favour of the State expropriating the Channel cables some 30 years back, are here to confirm the soundness of what I am advancing. In fact, these considerations are now immeasurably stronger arguments for the assumption by the State of all the cable links of the Empire.

Sir Henry Fowler, than whom no sounder, no more level-headed statesman exists, pointed out last year that "There were many weak spots and possible dangers inherent in the present system"; and he further said that this was a national service, and the public were entitled to demand that it should be undertaken by the State. We see France, with not a tithe of our commerce, with perhaps not a twentieth part of our carrying trade, with comparatively insignicant over-sea dependencies, preparing to spend 5 millions sterling as part of a scheme involving an outlay of 9 millions; Germany straining every nerve in the same direction; Russia, America, and even Holland, seriously contemplating having their own lines of cables; and gallant little New Zealand is facing a loss of £80,000 a year in order to follow the lead of the Mother Country, and establish penny postage. Must we give the world the spectacle of being the only nation of onlookers, trusting entirely to the action of private agencies, adopting a hand-to-mouth policy and leaving it to the accidents of commerce to provide us with the safeguards which should be established by Government. In the past our public departments have shown a curious and an inexplicable disregard both of the methods and principles which should govern transactions between the State and private companies. Apparently no foresight, no "intelligent appreciation of events before they occur," appear to have characterised their action. Let me give you one instance: in 1894 our Colonial Office contracted with the Eastern Extension Company to establish a cable from Singapore to Hong Kong, *vid* Labuan. Not a word is said as to what charges should be levied, nor as to the state of efficiency in which the cables are to be kept—no right of inspection, no access to accounts. The only stipulation is, that if the State chooses at any period, even when the cables are old and worthless, to buy them, that it should pay a sum of £300,000, which is said to be the cost of these cables when new.

Now compare with this the action of the French Government in what may be looked on as a parallel case. This Government in 1883 contracted with the same company to start a cable from Saigon to Haiphong, in Tonkin. In their convention every one of the points which I have just mentioned as being conspicuous by their absence in the Hong Kong cable agreement, has been inserted, but instead of providing for the option of purchasing the cables at the original cost when, owing to the cheapening of materials, or, owing to the deterioration of the cables, or, owing to the possibly inadequate state of repair in which the cable may have been kept it might be found that it is not worth even half of what it originally cost—how did the French Colonial Office deal with the position? They stipulated that the cables should be purchased, if desirable, at the actual market value, with regard to which experts were to be called in to decide. Look on this picture, and on that!

As to what should be the policy of the State in respect of any proposals made from time to time by foreign powers to utilise the United Kingdom as a mid-ocean station in carrying their cables to other countries—as to this and the other vital matter of the purchase of our private companies' cables, I am not in a position to speak just now. I have laid my views before a body of sound business men—open-minded men—and we must await the outcome of their deliberations.

Then, with regard to the Indian Telegraph rate, although Mr. Hanbury was advised to say, on May 22nd of last year, that the reduction of 1s. 6d. was all but signed, we are yet apparently as far off as we have been since 1886 from obtaining this or any other of the much-needed concessions. Whenever we turn to the companies we are told "there are lions in the path," and that we cannot expect any lowering of tariff except with the sanction and the consent of foreign powers. Do you consider this a proper position for Great Britain to occupy? Do you think for a moment that it is right that the Indian Government should be in the humiliating situation of going, hat in hand, to Germany and to Russia and to Persia, supporting, one on each arm, these coy and bashful companies, to beg of these countries, as good Samaritans, to let Indian rates be reduced, and thus to abate a grievance which has assumed the dimensions of a scandal?

As a contrast to the above position, let me draw your attention to the following:—In 1891 pressure was brought to bear by the Australian Governments on the companies for the lowering of rates to Australia, which then stood in the neighbourhood of 9s. 4d. per word. The companies urged the Indian Government to help them in making this reduction. This was done; the Indian "transit" charge was reduced by 50 per cent., from 7d. to 3½d. Not content with this very substantial concession, the Indian Government must needs enter into a "pooling" account, the result of which has been that on this account alone, India has paid in £46,000 more than she has taken out; mark you, that this route across India is the only practical route for the transmission of such messages; and, therefore, India had the whip hand. Thus while the public has been groaning under the admittedly intolerable burden of the 4s. rate to India (which has been maintained since 1886), we find the Indian Government in 1891 going out of their way to needlessly expend, for the benefit of Australia, money which should have been applied for the benefits of Indian messages. How does this impressive study of altruistic self-sacrifice strike you? One may well exclaim, "Thus do you labour, but not for yourselves." What is the reason that the promised reduction of 1s. 6d., promised to us by Mr. Hanbury a year ago, is still hanging fire? The India Office ascribe this to Russia and Germany. Let us put this to the test. It was only in February of last year that Russia exacted 7½ per cent. from the Indo-European Company as an increase on their "transit rate." Is it likely that in May of the same year she would so stultify her action as to consent to give back with one hand what she receives with the other? As to Germany, it is an open secret that she had determined not to renew her portion of the agreement; much less to agree to a reduction of the royalty which she receives, unless a certain concession, which I need not detail now, were granted by our Government. All these are facts; and yet in the face of them the eighteenpenny sop was held out to us. Once the object of closing our mouths seem to have been achieved, things have relapsed into the old state of stagnancy and indifference. There are also other points with which I will not now trouble you at length. Why has this incomprehensible generosity, in the wrong direction, been displayed by the Indian Government? For example, they pay full rates to the companies for Government telegrams; whereas other Governments, not so beneficent, generally get their messages carried at half rate! There is also another pooling arrangement of long standing, where India again displays her quixotic generosity at the expense of her commerce; but time will not permit of my enlarging on these matters now; sufficient to state that they do exist.

With the pessimism so often observable in Government officials, we are told that we have no right to ask for a reduction, because Indian traffic is absolutely stagnant and unprogressive, and that owing to the perfect codes no increase of traffic need be looked for. On the other hand, we learn of elaborate vocabularies being issued under the auspices of the International Telegraph Convention, the sale of which is going to be pushed by our Post Office for the purpose of compelling our merchants and our bankers to give up their own codes, and to adopt this new fangled vocabulary affected by the Convention. We have had experience that the Convention may be a passive hindrance; but it is not at all desirable that it should in any way become an active interference. Why must we, merchants dealing mainly with our own agencies or correspondents, established by our own enterprise in various parts of the world, principally in countries under British rule, be put to very considerable expense and no small possibility of error and misunderstanding in reorganising and compiling fresh code books to meet the requirements, whatever these may be, of the foreign telegraph administrations? I warn you, therefore, to keep a vigilant eye

upon this invidious encroachment, and to resist it to the utmost of your corporate power and influence.

Then as regards the non-elasticity in the number of messages from India proper; did the companies not trot out the same bogey about Australian rates, and have their gloomy anticipations not been wholly falsified! The same thing applies to South African rates. If India is unprogressive, surely Western Africa with the enormous development consequent on gold discoveries, the recent opening up of the "hinterland" and the transfer of the administration of the Gold Coast to the State, would seem to be a field of much activity and progress. How have the companies met this? have they attempted to anticipate the demand for cables by lowering their rates? While the French merchants can manage to send word to Kotonou, close to Lagos, by land and cable for 1s. 7½d., our West African people have still to pay from 6s. to 7s. per word.

I would ask the cable companies to show a little more foresight, a little more enterprise, and a little more initiative. Such a course would conduce to the benefit of the millions who use cables, and thus enure to their own ultimate advantage.

I have used up all the time at my disposal in showing you briefly where the shoe pinches. If you think fit to pass the resolution, and I hope you may see your way to do it unanimously, it will be useful for my Committee. But what would be still more useful, would be for every Chamber that is represented here to-day to maintain a persistent and a persevering agitation until we succeed in bringing about the change which both our experience in the past, and our aspirations for the future of the Empire, alike seem to indicate and to demand.

COMBINED TROLLEY AND CONDUIT TRAMWAY SYSTEMS.*

By A. N. CONNETT.

(*Concluded from page* 519.)

Special Conditions for a "Mixed" Line.—The first decision to be made for a line partly conduit and partly overhead is whether the plough shall be carried continually on the car, or removed and replaced at each junction point of the two systems. The latter is the simpler method. A roomy man-hole containing a man to do this work is all that is needed; but it needs no argument to prove that it is an undesirable and expensive method to adopt. One is then impelled to a method whereby the plough is always carried on the car as the trolley is, to effect which the plough must be raised or lowered at the junction points of the two systems. The most natural and the neatest solution is to raise the plough through the slot with no special arrangement in the latter. This has been successfully done in Berlin and Brussels. In the former city the plough is equipped with a wheel at its lower extremity, which runs up an inclined plane; and the contact-shoes working on horizontal axes pass through the slot by being depressed to a vertical position. The wheel then runs in the groove of the wheel rail, and it is raised clear of the track by the turn on a crank given by the motorman. At the same time the conductor loosens the bow sliding-trolley, and the operation is complete. The entire change can be made without stopping the car. No more perfect contrivance to accomplish this purpose could be devised. In Brussels the plough is raised by the motor man, the inclined-plane feature being discarded. A wheel trolley is used so that a stop is necessary to catch the trolley wire.

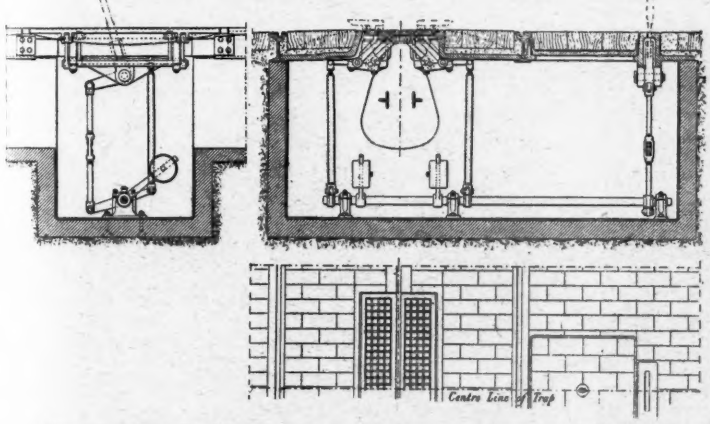


Fig. 9.—Trap-door Mechanism for Plough, Operated after Car has Reached its Position. Bastille-Charenton Tramway.

Both of these systems involve the use of "flappers." These are hung on horizontal axes, around which is a coil spring, one end of which is fastened to the fixed axis and the other to the flapper. The springs make the flappers press against the conductor bars.

There could be no good reason for not adopting one of the above plough designs for a side-slot conduit with 1¼-inch slot—for a centre-slot, with ⅝-inch width, their use is out of the question—if no other complications were involved; but the plough is one of the most difficult problems connected with the conduit system. The successful installation of two bare conductors in an open slot conduit is not as serious a matter as to take the current from these bars through the slot to the car motor. A plough must be strong enough mechanically to resist the shocks and wear and tear of ordinary usage, while not so strong but that it will yield before injuring the conductor-bar system in case of an accident. At the same time it must be electrically efficient under the most difficult conditions imaginable; bare collectors of current are connected to leads, which must be covered with insulation and mechanically protected by metallic wearing plates, the total width of which does not exceed ½-inch, with a ⅝-inch slot, this being the ordinary condition with a centre-slot conduit. The plough is often drenched with water and covered with slime and mud, which run down its sides from the open slot. The conditions are certainly severe for an apparatus to carry successfully a 500-volt circuit. In the author's opinion the design of the plough should have the first consideration, and the conduit and special apparatus connected with a road should be "built around" the plough as the base.

The flapper form of plough construction is weak mechanically. The friction of, and shocks due to uneven joints in, the conductor bars tend to twist the flappers about their horizontal axes. At the points where the bars are interrupted, such as at slot switches or at crossings, the shocks of this nature are very considerable. In actual practice the flappers are often wrenched off at these places. When released from their fixed position against the conductor bars the flappers take a position which is variable, depending upon the tension of the coil springs, which naturally cannot always be the same. A warped surface extension piece has to be fastened to the ends of the conductor bars, to guide the flappers to their normal position against the bars. These pieces give considerable trouble, and their use should be avoided, if possible. This form of construction does not permit the use of a fuse to connect the contact shoe with its lead; consequently a short circuit in the body of the plough, not being protected by the car fuses, would short circuit the line, and thereby stop the car traffic until the faulty plough could be discovered and raised out of the slot. The author believes it to be indisputable that other forms of plough are much more efficient, but none of them have the advantage of being able to be withdrawn from or lowered into the conduit without a special trap construction at a fixed point.

In the light of present experience the best plough is one having soft cast-iron shoes, pressed lightly against the vertical faces of the conductor-bars by semi-elliptic springs horizontally placed. The shoes preferably should be carried by horizontal links, which take all the shocks to which they may be subjected, leaving the springs free to do the work only of pressing the shoes outwardly. In this way the risk of deforming the springs is avoided. The links should be constructed so as to limit the outward course of the shoes. The conductor bars at switches and crossings are simply curved slightly outwardly. The shoes are connected to the leads by copper fuses. This plough construction is simple; in actual results it has proved itself to be efficient. It certainly is an improvement upon the "flapper" type.

The trap construction in its simplest form would be one in which the lids required to be lifted before the arrival of the car, and to be put back in place after its departure. This would be rightly considered a crude and laborious operation. Fig. 9 shows a form of trap which is operated after the car has reached its position. One throw of the lever opens the trap, which is so counterweighted that the effort necessary for this is almost inappreciable. This trap construction has given excellent results in France, where 40 of them are in operation. Where the flapper form of plough is used, the plough is lifted by means of an apparatus similar to a brake-staff, which is placed on the platforms. The plough is connected to this staff by means of cables which are guided by conveniently located sheaves. On account of the width of slot of the side-slot conduit, made necessary by the fact that it must be wide enough for the wheel flanges, the flapper form of plough has only been adopted for this construction of conduit. The ploughs are raised in guides attached to the side frames of the truck. In Brussels and Berlin the ploughs are not mounted on slides permitting a lateral motion across the car. The two slots of a double-track construction being located on the interior rails, it is necessary to carry two ploughs with a raising and lowering mechanism for each. If the requirements of the road demand cross-over switches from one track to another, a third conduit is necessary for a short distance at such points. The deviation of the slot to the centre with the necessary plough-carrier construction entirely obviates the difficulty of two ploughs and of a third conduit.

The use of the slides seems to the author to be a valuable feature of conduit electric railroads for the various reasons that have been given in the paper. Therefore the following explanation of a raising and lowering device for the plough, which will permit this sliding feature, is given in detail. Fig. 10 gives three views of such an apparatus. A are the side bars, B the top bar of the truck, and C the brake rods, which must be placed outside the wheels as

* Abstract of paper read before the Institution of Mechanical Engineers on 15th inst.

here shown; D is the plough shown in position on the side-slot conduit, it slides from this position to that of (1) on the centre slot, or of (2) the position of the slot of the other track when crossing from the interior conduit on one track to the similarly placed conduit on the other track. The slide ways are shown by the bars E. The bars F prevent the plough rising or tilting in the conduit, except in the central position (1), where the casting G, held in

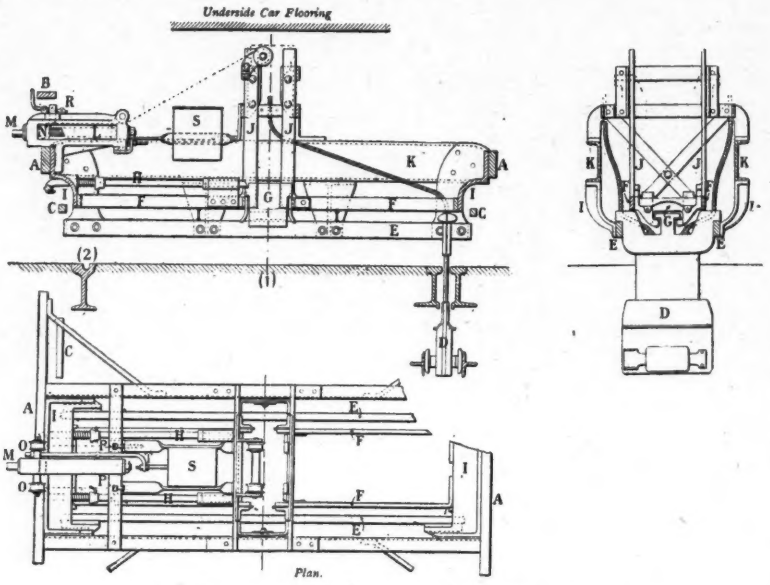


FIG. 10.—PLOUGH, WITH RAISING AND LOWERING DEVICE; PARIS.

position by the lock H, performs the same function. The sliding bars are held in position by the steel castings I. The projecting central piece J braced as shown holds the plough in its raised position. The whole apparatus is supported by the channel beams K, which are bolted to the side bars of the truck. In this way the vertical variation in height is limited to the small movement in the journal-box springs of the truck. The plough is raised in the following manner:—The fixed screw L is turned by means of a removable crank placed at M, the block N makes the course from one end of the screw to the other. In the figure the block is in its position with the plough raised. This piece carries the two rollers O, over which heavy link chains run. The latter are stationarily fixed at one end P, and at the other end to the casting G. The piece G is raised by an amount which is twice that of the course of the block N. The latch R automatically locks the block N in place when it reaches the end of its course. This prevents the trepidation of the truck from lowering the plough when it is in its raised position for the overhead trolley section of the road. The box S covers the double-pole switch which puts the car-leads in circuit, with the overhead or the conduit line as the case may be. This is done automatically with the raising or lowering of the plough by means of the rod T, which is moved by the block N when this is near the end of its course in each direction. Fig. 11 is a side view of the truck alone so equipped.

The author is indebted to Mr. E. W. Mix, the Chief Engineer of the Société des Etablissements Postel-Vinay of Paris, for his

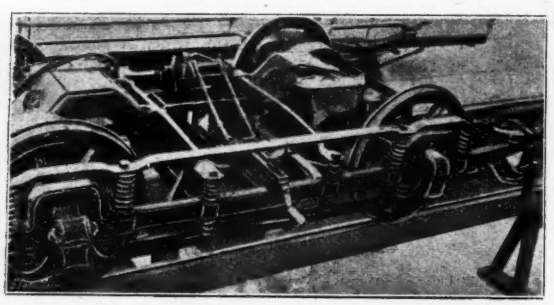


FIG. 11.—TRUCK EQUIPPED WITH PLOUGH-APPARATUS.

invaluable assistance in the design and manufacture of the apparatus above described. That it has been successful is largely due to his efforts.

It is a good plan to form the piece M so that it will only fit a controller-handle, which can only be removed from the controller on the "off" position. In consequence, if the handle is used to raise or lower the plough there can be no movement of the controller until the operation is finished. Generally there are two traps at the junction-points of the two systems, one for each track. The conductor of the car can operate the trap, but it is preferable to have a man specially stationed for the purpose, if the car traffic is at all frequent. In practice the operation is as follows: when the car has stopped with the plough over or under the trap—a mark on the track gives to the motor-man the exact position to stop—the motor-man gives his controller-handle to the trap-man who opens the trap, and lowers or raises the plough, closes the trap, and returns the handle to the motor-man. At the same time the conductor lowers the trolley from or raises it to the trolley wire. The whole operation takes on the average 10 seconds when the men become accustomed to it. If these junction-points coincide with regular stopping places to load or discharge passengers the loss of time due to this operation is inappreciable. The only arcing at the conductor bars and at the automatic switch S, fig. 10, is that due to the lighting circuit. This is too small to have any injurious effect upon the plough shoes, and the construction of the switch with a quick break is such as to remove any danger there also. If electric heaters should be used requiring rather large currents it might be necessary to cut them out of circuit during this operation. The car wiring for the mixed system is only slightly more complicated than for one system alone. The conduit circuit being completely insulated the ground wire must be removed from the controller. Two wires are run from the controller to two points on the double-pole switch S, fig. 10. These two points are thrown in by the switch with one pair of points connected to the two plough leads or with another pair connected to the trolley pole and the earth. In the electrical apparatus the only special precautions to take due to the use of the conduit are, first, to have the field coils insulated for 500 volts. With an overhead line the difference of potential between the field and the carcase of the motor is that due to the drop in the fields. But with the conduit it can happen that one pole of the conduit circuit is grounded, and that the fields are directly connected with the other pole. This would give 500 volts difference of potential between the carcase of the motor and the field winding. All standard motors should stand this condition, but it should not be omitted to be specified by the buyer. Second, when electric brakes are used, special insulation precautions are vitally necessary for the brake coils. A grounded conductor bar can subject these to 500 volts pressure during the entire time the car is on the conduit section. Not only is the annoyance due to burning up of the coils to be considered, but also that due to the short-circuiting of the line. An interruption of this kind is overcome by lowering the line voltage by means of a rheostat at the station, so that a current, the amount of which is controllable at the switch-board, may be sent through the fault. This excessive current will burn the plough fuses, thus clearing the line at the expense of leaving the faulty car "dead," to be hauled in by the succeeding one.

With a combined trolley and conduit line the conduit section

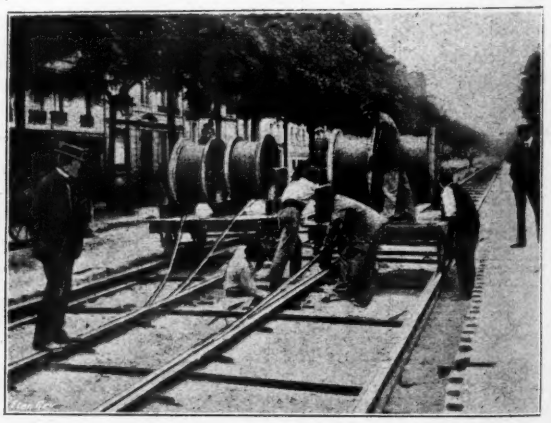


FIG. 12.—LAYING FEEDER CABLES IN CONDUITS; PARIS.

should have a separate circuit. It may be possible to operate it successfully with a grounded return, but few engineers would care to propose it. It is much better to increase the operating factor of safety by having both sides of the circuit insulated. In case the conduit section or sections are reasonably close to the power station, this may be done with a separate dynamo located there for the conduit circuit or by means of a motor-generator. If the cost of the leads to the conductor rails from the station is excessive, the motor-generator set may be stationed near the conduit section, and operated

from the overhead circuit. The proper solution may be one of many different ones depending upon the local circumstances governing a specific case. As a result of actual tests it has been found that the conductor bars of mild steel electrically connected with two bonds at each joint have a carrying capacity of about one-eleventh of copper bars of the same cross section. These bars can be largely increased in electrical carrying capacity by attaching to them bare copper cables for this purpose. It can be readily seen what an economy this method affords over that of laying insulated cables in ducts. Fig. 12 is a view of the method of laying these cables as employed in Paris. The cables there shown have a cross section of 250 square millimetres or about 500,000 circular mils. The cables are electrically connected to the bars at very short distances apart to avoid electrolytic action between the two metals.

Cost of Conduits.—The question of the cost of conduits must be treated in a general way, local circumstances being such a large factor in the determination of cost that no other method is possible. Some notes as to details of cost will be found in appendices I. and II. The side-slot conduit can be built for about £500 less per mile of single track than the centre-slot. In the special work there is an economy in the slide-slot also as ordinarily built, as there are fewer frogs with three rails than with four. But if the slot is deflected to the centre, as has been recommended in the paper, the economy cannot be realised; on the contrary, the cost will be somewhat greater, due to the cast-steel deflecting pieces and the bent slot-rails. It is generally stated that a conduit road costs twice as much as an overhead-trolley road. This statement may be misleading, owing to the fact that an overhead-trolley road may be very variable in its cost, depending upon pavement requirements, overhead construction adopted, and many other local conditions, such as the regulations for the return current by the rails. But the construction of the conduit part of a road is quite independent of these factors; for an overhead-trolley road which would cost £5,000 per mile of single track, it is quite probable that the same road with the conduit construction would cost £11,000 for the same length, that is, the conduit properly speaking would cost £6,000 in excess of an overhead-trolley road. If the overhead-trolley line should have a first cost of £10,000 per mile of single track, there is no reason why the use of a conduit on such a line would double the cost as in the first instance. Roughly speaking, the cost of a conduit in this latter case would be £16,000. To arrive at an approximate comparison of the cost of the two constructions, it is fair to assume that the cost of paving and of the wheel rails is the same in both cases. For the conduit there should be added per mile of single track approximately the following material and labour:—105 tons of slot-rail, 40 tons of conductor-rails, 210 tons of cast-iron, £120 excess for bolts, &c., porcelain insulators £35, 1,400 cubic yards excess excavation, 1,200 cubic yards of excess concrete, £600 excess labour for track-laying, £400 sewer connections. Crossings, turnouts, and special track work in general, cost 200 per cent. more on an average for the conduit than for ordinary track. A cost which is wholly indeterminate is that of removing sub-surface obstructions. This, as has been explained, can often be reduced by varying the conduit depth to suit special cases.

Considering alone the items above enumerated they will amount to between £5,500 and £6,000. Deducting the cost of an average overhead construction, it can be roughly be said that a conduit road will cost from £5,000 to £5,500 more per mile of single track than a trolley road under the same conditions, to which should be added the increased cost of special track work and the removal of underground obstacles. Under ordinary conditions the difference in cost will vary between the limits of £7,000 and £9,000.

APPENDIX I.

Details of Cost in United States.—Table 1 gives the actual cost per single-track mile of the conduit roads installed by the author in 1895—6 for the Metropolitan Railway Company of Washington, D.C.

Cost of Metropolitan Railway Company, Washington, D.C.

Straight track	...	101,660 ft.
Curved track	...	9,190 „
		110,850—say 21 miles of single track.

	£	s.	d.		£	s.	d.
Rails and splice bars:—							
Wheel-rail	5	15	0	per ton.			
Slot-rail	6	8	6	„			
Guard rail for curves	9	10	0	„			
Conductor-rail	8	8	0	„			
Joints complete	0	4	10	each.			
Per mile single track					1,858	6	8
Cast-iron (yokes, insulator frames, covers, &c.), 215·5 tons at £5 15s. 7d.					1,245	8	2½
Bolts, tie-bars, clips, &c.					312	10	0
Bonds for conductor-rails					97	18	4
Track laying (all labour and hauling)					589	3	4
Temporary track...					33	6	8
Excavation of all kinds except for cable ducts, 2,507 cubic yards at 3s. 10¾d.					488	6	10
Sewer pipes laid and brickwork for duct manholes...					99	7	6
Cable ducts:—							
10,616 ft. 12-way duct at 4s. 9½d.							
41 „ 8 „ „ 3s. 6½d.							
21,354 „ 4 „ „ 2s. 2½d.	£4,894	3	9		233	1	1
113 „ 2 „ „ 1s. 5d.							
Excavation for cable ducts, 9,207 cubic yards at 3s. 4d. = £1,534 10s.					73	1	5½
Concrete, first grade, for conduit (1 barrel Portland cement, 12 cubic ft. sand, 22½ cubic ft. broken stone) 765 cubic yards per mile at £1 9s. 2d. ...					1,115	12	6
Concrete, second grade, for paving base, &c., (1 barrel Cumberland cement, 10 cubic ft. sand, 20 cubic ft. broken stone) 514 cubic yards per mile at 18s. 1d.					464	14	10
Stone paving using old setts, 42,126 square yards at 3s. 3d. ...	£ 6,845	9	6				
Asphalt pavement, 91,716 square yards at 6s. 0½d. ...	27,705	17	6				
	£34,551	7	0		1,645	6	0
Special track work and curves					783	6	8
Extra bills of street contractor					239	11	8
Removal of sub-surface obstructions					666	13	4
Total cost per mile of single track ...					£9,945	15	1

The metallic structure cost less at that date than it would now. The temporary track is a very low item, the authorities having permitted a flat strap-rail to be laid on the pavement (mostly asphalt) by means of flat tie-bars with special seats at their extremities. It should be stated that this city is an exceptionally favourable one for the construction of conduit road, the streets being wide and with little traffic upon them, and the supervision being that of the thoroughly trained engineers of the United States Army.

The author has been given a pamphlet containing some diary notes kept by Mr. William C. Gotshall, engineer in charge of construction of the Second Avenue Railroad Company of New York. The pamphlet concludes with the following estimate of the cost of this road per mile of single track. It should be stated that this estimate is not Mr. Gotshall's, but the work of the compiler of the pamphlet:—

Total Cost per mile of Single Track, Open Conduit System, Second Avenue Railroad Company, Compiled from Diary of W. C. Gotshall.

	£	s.	d.
Labour, digging trough, removing old track, repairing concrete, removing excess dirt, hauling all track work, £1 10s. 11½d. per linear foot	8,173	0	0
Insulators, 5s. 8d. each	199	9	7
Iron work, excluding yokes, 7s. 4d. per linear ft. ...	1,375	7	0
Cost of iron yokes, 224·7 tons at £5 4s.	1,168	8	10
Concrete, ⅔ cubic yard per linear foot, 8s. 2d. per yard	808	10	0
Haulage on yokes and iron work	117	1	8
Total without paving ...	£11,841	17	1

The above does not include cost of feeder duct.

In comparing this cost with that of the Washington conduit, it should be borne in mind that the items of cost of special track work, feeder ducts, paving, bonds, sewer connections, temporary track, are not included in this estimate, while they are in the Washington costs (Table 1).

The cost of concrete is put down at 8s. 2d. per cubic yard. This low cost is evidently an error of compilation. Other information in the pamphlet seems to prove that this cost should be from 2½ to 3 times this amount.

APPENDIX II.

Estimated Cost in England.—The author ventures to submit the following estimate of cost per single-track mile in England at ruling prices of material and under fair average conditions. The construction here figured upon is a centre-slot conduit with yokes spaced 3 ft. 6 in. centre to centre; the yokes of the same weight and general dimensions as those used on the Paris lines. Yokes need not be inordinately heavy, but they should by all means be close together to preserve the slot width, a much more important matter for a conduit electric than for a cable road.

Estimated Cost of Single-Track Mile of Conduit Electric Tramways in England for average Conditions (December, 1900).

	£	s.	d.	£	s.	d.
Wheel-rails, 90 lbs., 141 tons per mile at £7.	987	0	0			
Joints, 0·67 ton at £8	5	8	0			
Slot-rails, 66 lbs., 105 tons at £8 ...	840	0	0			
Conductor-rails, 28 lbs., 44 tons at £8 ...	352	0	0			
				2,184	8	0
Haulage, 290·67 tons at 4s.				58	2	0
Bolts, washers, keys, &c., 4·16 tons at £18	74	18	0			
Tie-bars, 13·5 tons at £15	202	10	0			
				277	8	0
Insulators complete with clip, 755 at 6s. 2d.				232	16	0
Cast yokes and insulator pit covers:—Yokes, 210 lbs. each, spaced 3 ft. 6 in. centre to centre, 210 lbs. × 1,510 = 317,100 lbs. = 141·5 tons. Insulator pit covers, 117 lbs. each. 755 × 117 = 88,335 lbs. = 39 tons. Total 181·5 tons at £10				1,815	0	0
Haulage, 181·5 tons at 4s.				36	6	0
Bonds				110	0	0
Concrete for tube, 1 cement, 2½ sand, 5 stone, 0·2 cubic yard per 1 linear foot 5,280 × 0·2 = 1,056 at £1 8s.				1,478	8	0
Concrete for paving, 1 cement, 3 sand, 6 stone, 0·10 yard per 1 linear foot × 5,280 = 528. 528 × £1 4s.				633	12	0

Wood paving, 6,373 square yards at 11s.	3,505	3	0
Excavation, 2,950 cubic yards at 5s.	737	10	0
Sewer connections and manholes for same	400	0	0
Plate laying, including average amount of special track work, 5,280 at 3s.	792	0	
Temporary track (1 track laid and repaved on side of street with turn-outs) at £1,350 per mile of street (divided into two tracks for double-track construction)	675	0	0
Special track work of cast-steel construction with hardened centres	1,128	0	0
Obstructions (necessarily very indefinite)	1,000	0	0
Feeder ducts	800	0	0
Extras and contingencies	630	0	0
	£16,493	13	0

Certain costs, notably those for temporary track, feeder ducts, obstructions, special track work and curves, must be largely hypothetical, but the author believes that for average conditions and for this type of construction this figure will be reasonably safe, except for the item of sub-surface obstructions. This may be small or again inordinately large, depending upon local circumstances.

In closing, the author wishes to emphasise one point, the transmission system for a conduit road being wholly an insulated one can be calculated for the most economical drop of potential, which is not the case of an overhead line with rail return. Considerable saving, either in copper or boosters or both, can so be effected, which should be put to the credit of the conduit system in any estimate of the cost of such a system.

ELECTRICAL MINI PLANT IN AUSTRALIA.

A DESCRIPTION of the pumps installed in the new Havillah, the Charlotte Plains Proprietary, and the Junction Deep-Lead Gold Mines and in the Victorian Deep Leads Mine, and details of the plant of the Deep Leads Electric Transmission Company itself appear in a recent issue of the *Mining Journal* from which we extract the following:—

"The adaptation of electricity to mining work of all kinds is daily on the increase; but its application to pumps in deep mines has not been so extensive, although a large number have been erected in the anthracite and other mines in America. As compared with the various other systems in use for freeing mines from water, electric power presents some striking advantages—namely, in reducing first cost in expenses consequent upon separate installations, especially where, as in this instance, power is supplied to a group of mines at a considerable distance from one another. The space required and freedom allowed in fixing the position of pumps in a mine are also matters tending to greater economy, to which might be added the ease with which the electric cables can be conveyed to where they are required, as compared with steam or air pipes and pump rods. Again, there is no loss similar to that encountered by the condensation of steam in pipes to pumps underground, and all these matters are distinct advantages in favour of electricity.

"In the present instance the water in the mine is raised 350 ft. at the rate of about 2,000 gallons per minute. The pumps are of the double-geared three-throw double acting type, driven by an electric motor of 250 H.P., running at a speed of 450 revolutions per minute, the electric power being transmitted from the central power station at Charlotte Plains. The motion is transmitted from the motor to an intermediate shaft, 8 in. in diameter, by spur gearing, thence to the crankshaft by a second set of two spur wheels and pinions, the speed of the crank shaft being 30 revolutions per minute. The wheels of both sets of gear are made of cast-iron in halves and rigidly bolted together, the pinions being of cast-steel; the wheels of the second set of gearing are 8 ft. diameter and 12 in. face, having machine-cut teeth. There are six single-acting working barrels connected together in pairs. The plungers are 11 in. diameter and 36 in. stroke, one plunger working in each pair of working barrels, which are externally packed. Each working barrel is fitted with a by-pass and valve between it and the delivery pipes to relieve the pumps when starting. The valve boxes are 12 in number, of the pot type, six being used for the suction and six for the delivery, all made of the same pattern. All the parts are mounted upon a large cast-iron bedplate or framing made up of 11 sections rigidly bolted together. The motor bed also forms a portion of the main bedplate, and notwithstanding that it is split up into small sections for convenience in getting down the shaft, it is when bolted together on its foundation a perfectly rigid structure, and a self-contained machine. The crankshafts are 12½ in. diameter. There are three suction pipes 11 in. diameter, one for each set of plunger barrels. Each suction pipe is supplied with a vacuum vessel and a foot valve in the pump well. There are also three 11 in. diameter delivery pipes, each fitted with a stop valve terminating in a junction piece connected to the 20-in rising main. The junction piece is supplied with a large air vessel for the purpose of reducing all shocks from water hammer to a minimum. The air vessel is provided with an automatic apparatus to keep it always full of air. The delivery column pipe is 340 ft. high, in 15 ft. lengths, 20 in. internal diameter, made of mild steel, ⅜ of an inch thick, lap-welded and fitted with cast-steel flanges screwed on the pipe and provided with recessed joints. The space occupied by the pumps is about 39 ft. in length, 22 ft. 6 in in width, and 20 ft. in height; the weight of the pumps without suction or delivery pipes beyond the limits of the bedplates is about 77 tons 10 cwts. They are bolted to a bed of cement concrete, built in a chamber 45 ft. long × 26 feet wide, constructed of the same materials, and arched with Monier concrete in a very substantial manner, forming a perfectly dry housing underground for the machinery.

"The Cornish pumps installed in the Victorian Deep Leads consist of a double set of 20-in. diameter plungers, having a maximum stroke of 8 ft. and a minimum stroke of 4 ft. The delivery column is 22 in. internal diameter, of lap-welded steel, having cast-steel flanges with hydraulic joints. Each set of plungers delivers into this 22-in. delivery column. The first plunger workings are set 135 ft. from surface, and the second set 175 ft. lower, making a total depth of 310 ft. Below this is the well, in which the suction pipes are placed. Each set of pumps is connected to massive bell bobs. These bobs are connected together; thus the whole weight of each set of pump rods, plungers, &c., is balanced by this means, no balance boxes, with their necessary cumbrous loading, are required, and a saving is effected by having only one delivery column. The 'bell bobs' are connected with the pumping crank by the usual sweep and connecting rods. The pump crankshaft is driven by a powerful train and gear, which, in turn, is connected to the electric motor by nine manilla driving ropes. On the first countershaft is fitted a patent Weston-Capen friction clutch, which enables the pumps to be started as slowly as may be desired. The plant, foundations, &c., throughout are of massive design, and constructed on plain and economical lines with a view of saving in first cost without sacrificing the efficiency of the plant in any way, and with the cheap motive power, the working expenses will show a considerable saving over the usual system adopted in alluvial deep-lead mine pumping. The entire plant at this mine is capable of delivering 108,000 gallons per hour. The machinery was designed by J. G. White and Co., of New York and London, and erected under the direction of Messrs. Geo. W. Kelly & Lewis, Melbourne. A good deal of the plant was made by Messrs. T. Piggott & Co, Limited, Birmingham, England. The rising mains for the pumps were made by Stewart & Menzies, Limited, Glasgow, the rope transmission and train gear by Poole & Co., Baltimore, U.S.A., and the working parts by various Victorian engineers.

"At the power-station there are three engines of the horizontal cross-compound condensing side crank type, built by the Buckeye Engine Company. The principal dimensions are—high-pressure cylinder, 18¾ in.; low pressure, 36 in. diameter, with a common stroke of 27 in. The engines are designed to operate under 150 lbs. steam pressure, and a vacuum of 26 in. of mercury developing 600, with a maximum of 735 I.H.P. The engine shafts are 16 in. diameter, excepting at the bearings; these are 11 in. diameter, and 20 in. long. The length between crank discs is 16 ft., and the weight 6 tons. The total weight of each engine without the rotating parts of the electric generator is 36 tons. The English governors are of the shaft type, and are possibly the newest of their kind in the colony. The new features are the inertia wheel and connections. The governor arms have roller bearings pivotted to a containing wheel 4 ft. diameter, which is fixed to the shaft. The inertia wheel being free to revolve slightly as the speed of the engine increases or decreases actuates the cut-off valve, which is of the piston type and works within the main valve, the spindle of the former passing through that of the latter. It is claimed for this governor that when each engine is operating on a separate circuit the instantaneous variation in speed will not be more than 2 per cent. for any instantaneous change in load between friction load and 735 I.H.P. All the working parts are fitted with sight feed lubricators. The Crosby Steam Gauge Company, of New York, supplied the steam and vacuum gauges; each gauge has a separate automatic recorder with chart. The engine indicators by the same maker have an electric attachment, so that each cylinder can be indicated at the same moment. The surface condensers are supplied by the Wheeler Condensing Company, of New York, and are rectangular in shape, with 882 seamless-drawn brass tubes, ⅝ in. diameter, and 9 ft. 2 in. long, capable of condensing 12,600 lbs. of steam per hour under a vacuum of 26 in. of mercury and with circulating water of 90° temperature. The air and circulating pumps are of the Blake type. The third engine unit has the latest Wheeler 'Admiralty' surface condenser mounted upon a Blake combined air and circulating pump with Simplex valve gear. All the parts exposed to water are made of brass and phosphor bronze; salt water will be used for condensing, and the cooling surface is 1,400 square feet."

(*To be concluded.*)

Oldham.—At the Oldham County Court last week an action was brought by a workman against Messrs. John Barker and Sons, Limited, of Park Street Ironworks, Oldham, for goods sold. The defendants put in a counterclaim for damages sustained through a breach of contract in the supply of certain automatic electric switches applicable to hoists and cranes. Judge Bradbury suggested that an expert be requested to report upon the technical points in the claim and counterclaim, and Mr. Newington, electrical engineer to the Oldham Corporation, was appointed.

THE BOARD OF TRADE INQUIRY re ELECTRICAL PRESSURE.

(*Concluded from page* 522.)

Sir Courtenay Boyle sat again at the Westminster Town Hall on Friday, to consider the application of the electric light companies for an alteration in the pressure from 100 volts to 200 volts.

Mr. Moon, arguing for the Chelsea Electric Light Company, denied that there was any acute controversy as to the efficiency of the 200-volt lamp. The whole of Glasgow and St. Pancras were supplied with the 200-volt lamps, as were three-parts of the consumers of Chelsea. The only matter of controversy was the relative efficiency—that was to say, whether relatively they got the same light with the 200-volt lamp for the same money. As far as Chelsea was concerned, there had so far as he knew been no complaints with regard to the County Council clause, he was perfectly willing to stand upon an open arbitration, but he objected to any conditions put on the arbitrator's discretion. As to the Metropolitan Company the application was for a change from 50 volts to 100 volts, and there could be no question of efficiency there. Under those circumstances he should call no evidence for the Metropolitan Company.

Mr. Glen, appearing for the Paddington Borough Council, said he was concerned merely with the Metropolitan Company. He did not suggest that the Metropolitan Company was doing anything unreasonable, but the company was asking to be put in the same position as the other companies, so that at any time they thought fit, they might increase to the 200 volts. Consequently he failed to see that there was anything special in the case of the Metropolitan Company. He strongly supported the clause of the County Council with regard to arbitration if the change was to be made.

Mr. Dankwerts, K.C., addressing Sir Courtenay Boyle for the City Corporation, quoted answers given by Prof. Kennedy to show that the consumer would gain no advantage whatever from the change. It was true that Prof. Kennedy said that the consumer would be in no worse position, but that was a point on which he joined issue. He contended that the 200-volt lamp was a more expensive lamp and did not last so long. If the change was to be made there should be an indemnity to those who had to change, and he suggested that it should be by way of a discount on the price charged, say, 10 per cent.

Mr. Roskill contended that there was no vested right in any consumer in the City of London to prevent the electric light company altering the pressure. The Board of Trade had the power to come in and authorise the alteration. It would be a monstrous thing if a man should be allowed to blackmail these statutory companies when he possessed nothing but what could be taken away by the Board of Trade at any time. He submitted that the clause drafted by the Board of Trade amply protected the consumers, both large and small.

This concluded the inquiry, and Sir Courtenay Boyle said he would report to the Board of Trade.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

5,087. "Electric alarm attachment to nickel alarm clocks." D. Mundell. March 11th.

5,088. "'Simplex' trolley head for electric tramcars." J. D. Russel. March 11th.

5,098. "Improvements in multiple conductor cable, terminal or analogous fittings." G. H. Nisbett. March 11th. (Complete.)

5,121. "Improvements in insulating strips or cores for rheostats, electric heaters and similar devices." P. M. Justice. (The Erie Exploration Company, United States.) March 11th. (Complete.)

5,134. "Improvements in conduits for electric cables and the like." C. A. W. Hultman. March 11th. (Complete.)

5,136. "Improvements in and in the method of producing composite electro plates." W. C. Clouse. March 11th.

5,145. "A combined ozoniser medical coil and lamp for use for medical and other purposes." The Electric Ozone Syndicate, Limited, and R. F. W. Smith. March 11th. (Complete.)

5,158. "Improved means for increasing the efficiency of electric incandescent lamps." J. W. T. Cadett. March 11th.

5,164. "An improvement in breaks for induction coils." J. Carpentier. March 11th.

5,165. "An improvement in switches for varying electrical resistance." Siemens Bros. & Co., Ltd., and M. Hird. March 11th.

5,171. "Improvements in non-inductive resistances." W. du Bois Duddell and T. Mather. March 12th.

5,172. "Electric thermal devices for working switches registering apparatus and the like." G. Charlton and W. E. Barton. March 12th.

5,175. "Self-lubricating pulley for electric car trolley-head." R. M. Tyrer. March 12th.

5,220. "Improvements in electric bipolar dilator." C. L. Mosher. March 12th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 25th, 1900, being date of application in United States.) (Complete.)

5,227. "Improvements in or relating to the arrangement of electrical cables or groups of conductors." C. A. W. Hultman. March 12th.

5,247. "Improved switch for controlling electric motors." A. G. Bloxam. (Helios Electricitäts Actien Gesellschaft, Germany.) March 12th. (Complete.)

5,260. "New or improved apparatus for automatically registering the time during which an individual telephone instrument has been in actual use." A. C. Krause. March 12th.

5,263. "Improvements in receivers for electric demand indicators." A. Wright and The Reason Manufacturing Company, Limited. March 12th.

5,265. "Improvements in and relating to the recovery of precious metals by electrolysis." J. F. Webb, J. E. Lilley, and J. Chapman. March 12th.

5,292. "Improved system of guard wire protection for electric trolley or other high pressure uninsulated wires." E. W. Cowan, A. Still, and T. L. Miller. March 13th.

5,305. "Improvements in micro-telephones." E. Volkers. March 13th. (Complete.)

5,306. "An improved means of picking up positive electric pressure from a closed tubular rail, or subway, without a longitudinal slot, or a surface contact, by a wheel suspended over it, and returning the negative current to the tube." R. C. Sayer. March 13th. (Complete.)

5,332. "Improvements relating to electro-therapeutic apparatus." A. W. Courtney. March 13th. (Complete.)

5,343. "A method of and apparatus for actuating devices on public electric supply or distribution systems." A. Wright and The Reason Manufacturing Company, Limited. March 13th.

5,391. "An improved switch for electrical lampholders and the like." J. H. Bosworth and G. Major. March 14th.

5,402. "Improvements relating to electric pendant lamps." R. H. Best. March 14th.

5,411. "Improvements in electric measuring apparatus." R. Ziegenberg. March 14th. (Complete.)

5,413. "Generator for the intensification of gravitational or electric stress." G. Earl-Adams. March 14th.

5,421. "Improvements relating to electrical reformers." A. Nodon. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 17th, 1900, being date of application in France.) March 14th. (Complete.)

5,427. "Improvements in the manufacture of electric cables and apparatus therefor." H. W. Dover. March 14th.

5,449. "Improvements in underground conduits and accessories therefor for use with electrically-propelled tramcars and like vehicles." G. Wilkinson. March 14th.

5,452. "Electrically-heated radiators." W. H. Milnes. March 15th.

5,460. "Improvements in and relating to prepayment meters for the supply of electricity." J. Finlayson and W. Scott. March 15th.

5,464. "Improvements in or connected with overhead conductors for electrical tramways and the like." H. H. Hall and G. Smith. March 15th.

5,477. "New or improved means for diverting or cutting off electric currents in overhead electric trolley or like wires or cables and guard wires and disconnecting broken cables or line wires." J. E. Hill. March 15th.

5,487. "Improvements in electric heating and cooking apparatus." F. W. Schindler. March 15th.

5,488. "Improvements in electric bell pushes." J. S. Ross. March 15th.

5,489. "Improvements in or relating to electric tramways." F. G. Sealy. March 15th.

5,496. "Improvements in electric meters." E. Batault. (Date applied for under Patents, &c., Act, 1883, Section 103, August 17th, 1900, being date of application in France.) March 15th.

5,510. "Improvements in commutator brushes and brush holders for electric motors or dynamo-electric machines." R. Lundell. March 15th. (Complete.)

5,528. "Improvements in wireless telegraphy." J. R. Milnes. March 15th.

5,542. "Improvements in and relating to trolley-wire guards or 'protectors' of overhead driven electric tramways." J. T. Pearson. March 16th.

5,547. "Improvements in electric railways and tramways on the sectional conductor system." J. Milnes. March 16th.

5,560. "Improvements in electrical switches." C. M. Dorman and R. A. Smith. March 16th. (Complete.)

5,562. "Improvements in and relating to devices for cutting out broken or short-circuited sections of trolley wires used in connection with electric traction systems." J. W. Donaldson. March 16th.

5,570. "Improvements in electric arc lamps and electrodes therefor." C. A. Lee. March 16th.

5,589. "Improvements in electric telegraphy." A. Muirhead. March 16th.

5,592. "An improved method of manufacturing filaments for incandescing electric lamps." W. L. Voelker. March 16th.

5,598. "Improvements relating to portable electric lamps." M. Katser. March 16th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

8,840. "Improvements in incandescent electric lighting systems." British Thomson-Houston Company, Limited. (A. G. Davis.) Dated April 27th, 1899. Lamps having incandescent bodies which conduct only after preliminary heating, and more freely at high temperatures, are supplied with a constant current, either continuous or alternating, from a suitable transformer or other source. Such lamps are preferably connected in series, and each provided with a film or other cut-out, and a short-circuiting switch. The incandescing body may be a magnesia or porcelain, in or around which is a metal wire to effect preliminary heating, as described in Specification No. 5,941, A.D 1899. 8 claims.

8,913. "Improvements in cut-outs, fuse boxes, and analogous electrical fittings, and in connections for such fittings, and other electrical purposes." R. F. Hall. Dated April 28th, 1899. A fuse box having special terminals or connections, the base is divided longitudinally by a division and transversely by the divisions. The fuse wires are passed through perforations in the cross piece. The terminals or connections are metal pieces having cuts at the ends to receive the wires which are clamped by the screws. The metal terminals fit in holes in the base as shown. The metal pieces may be employed in ceiling roses or as couplings for connecting lengths of conductors together. 2 claims.

8,949. "Improved starting mechanism for electric motors." R. Belfield. (T. S Perkins.) Dated April 28th, 1899. Switches for electro-motors are so constructed that the contact arm is returned to the off position with an over or under load. The hub of the arm of the resistance switch is fitted with two teeth, the former of which engages with teeth on a second hub carrying an insulated blade, to connect the hubs with a contact. The hubs are in electrical connection. The contact arm is held with all the resistances cut-out by an electro-magnet which releases under the action of a spring when the current fails. An overload electro-magnet is provided, which with excessive current, attracts its armature making contact and short-circuiting the magnet. 3 claims.

8,961. "Method of and apparatus for effecting the storing up of speech or signals by magnetically influencing magnetisable bodies." V. Poulsen. Dated April 29th, 1899. Relates to means for recording and reproducing messages, such as telegraphic or telephonic messages, by means of an electro-magnet acting upon or being acted upon by a magnetisable wire or strip. A cylinder is covered with a

close spiral of steel wire, which is to take the place of the phonographic plastic cylinder, and an electro-magnet is mounted in a sliding carriage to take the place of the stylus. The carriage is mounted on a rotating tubular frame and is provided with a centrifugal lever, which brings the core of the magnet against the wire while the frame is rotating. The removal or obliteration of the messages from the strips is said to be obtained by traversing the wire, &c., with a magnet carrying a steady continuous current. 3 claims.

8,976. "A safeguard against screw loosening on electric incandescent lamp-shade holders." W. Schlosser and H. Moores. Dated April 29th, 1899. Lamp-shade holders for electric incandescent lamps having screws for holding the shades are provided with springs supporting caps with tongues which grip the milled heads of the screws to prevent their withdrawal owing to vibration. Each cap may be supported by a vertical spring on an arm of the holder, the arms may be grooved or slotted to receive the springs. Or the caps may have upward extensions, which are connected together by springs passed round the holder. Other small modifications may be made. 4 claims.

9,009. "Improvements in apparatus for breaking high-tension circuits." C. Sprecker. Dated April 29th, 1899. Relates to means for breaking high-tension circuits locally, or from a distance, or automatically, and for minimising arcing. In the arrangement described, one terminal carries a fixed contact, which is formed of spring wires. The other terminal carries a tube in which slides a rod fitted with a carbon plug. A spring tends to withdraw the rod within the tube. The circuit is made by forcing the rod out, say by a cord, and it is locked in this position by a bolt engaging in a slot. The bolt may be released to break the circuit by means of a cord, or by an electro-magnetic device which is controlled from a distance, or by the current itself should it become excessive. The terminals are fitted with wire extensions which take and break up the arc formed. Instead of the wires, the gap may be covered by a double chimney in which are fitted partitions. An arrangement for breaking the circuit in case of fracture of the line conductor is provided. The end of the bolt engages with one end of a lever, on the other end of which the conductor rests. Should the conductor fracture, the weight pulls down the end of the lever, raising the bolt, and thus releasing the rod. 5 claims.

9,101. "Improvements in or relating to globes or protectors for electric and other lighting apparatus." J. G. Pennycuick and F. W. Barrett. Dated May 1st, 1899. To increase the field, and equalise the intensity of the illumination from the electric or other lamp, the external surface of the globe is formed by horizontal series of lenses. The upper series prevent the loss of the upwardly diverging rays by refracting them downwards towards the rays which are refracted more or less horizontally by the series. The lowest series refracts the rays falling thereon so as to illuminate the space immediately beneath the lamp. 5 claims.

9,134. "Improvements in or relating to electric accumulators." F. Mouterde. Dated May 1st, 1899. Relates to plates or electrodes of the type described in Specification No. 3,712, A.D. 1896, in which the battery is made up of two or more concentric cylindrical electrodes. The invention consists firstly, in providing the external electrode with a bottom part so that it serves also as a cell and allows the usual external casing to be dispensed with; secondly, in rendering the battery water-tight by providing it with a cover which may be of lead and be soldered on to the electrodes after the other electrodes have been put in place; thirdly, in perforating the negative electrode or electrodes with a number of holes so that the electrolyte can penetrate to the active material, which is placed on both sides of the cylinder; fourthly, in mixing with the active material pumicestone which has been powdered and rendered conductive by being coated with silver; and, fifthly, in winding around the exterior of the negative electrode or electrodes one or more layers of thin slotted and corrugated lead plate, in the channel of which active material is placed and which layers also serve to prevent the active material from falling off the electrode. The slots or openings are formed in the lead plate by passing it between two cylindrical rolls, one of which is formed with a number of projections upon it which resembles cog-wheel teeth, and the other is a plain cylinder of papier mache. The projections or teeth are arranged in rows which break joint with each other and form rows of similarly arranged embossed parts in the lead plate when it is passed between the rolls. The embossed parts are then planed off so as to form rectangular openings, which are subsequently enlarged into a rhomboidal shape by stretching the plate. 5 claims.

9,209. "Improvements in and relating to electric arc lamps." R. Upton. Dated May 2nd, 1899. Relates to arc lamps. The frame consists of a central tube, a cover, a rectangular box, and two side rods. The tube carries split clamps supporting a regulating lever, a series solenoid, two impedance coils, a dash-pot and a thick asbestos heat guard. A casing is connected by bayonet slots to pins on the cover, under guard plates. Each coil is clamped between two arms of the central split clamp; or otherwise each coil is secured by vertical clamps on a horizontal plate on the central clamp. The lower carbon is secured in a socket, which also has a packed cup to hold an arc-enclosing globe in a packed groove in the base of the box, in which the packing is supported by the edge of a cup screwed on a projection to form a gas check for the upper carbon. The socket is supported on a recessed yoke which rests on a spring on one side rod, and is slotted and recessed to engage a nut on the other, so that it can be released and turned to remove the globe and lower carbon-holder. The globe can be cleaned with hydrofluoric acid. The rods carry a flat reflector. The upper carbon is inserted in a split holder which slides in the central tube, and contains springs bearing against one another and against the tube to maintain electrical connection therewith; a modified holder has a screw projecting upwards, with two nuts, one securing a number of curved contact-springs, and the other situated between the inturned upper ends of the springs to hold them outward, adjustably. To indicate when the carbons require renewing, the holder in descending comes in contact with a spring and supplies current to a lamp, visible through an opening in the casing. The upper carbon passes through a thick clutch-plate, the hole in which is cylindrical below but conical in its upper half, with or without an intermediate shoulder. The clutch is connected by a rod with the counterweighted lever, which is connected by a spring with the core of the series solenoid. The core is of soft iron with a filling of laminated iron. The outer end of the clutch is connected by a spring with an arm fixed adjustably on the rod; this is stated to prevent overfeeding when the lamp support is subject to vibration. The lever is linked to a dashpot which slides between a stationary outer cylinder and a piston; the sliding pot is perforated at the top and carries a loose cap, which closes the perforations when the pot is rising. The solenoid is wound with layers of asbestos, or has rods inserted between its coils, by the latter arrangement a solenoid with a cylindrical cavity is made square externally. The solenoid is provided with an armature supported below by V-springs adjustable in the clamp. One of the impedance coils is made with a connecting loop, extending from the middle of each layer, and a flexible connection may be clamped to any loop to include a part of the coil in circuit; the other coil may also be included. A disconnecting switch is provided on the cover. The cover may also carry an adjustable resistance and a double-pole two-way switch to connect the lamp in either of two circuits, one alternating and the other continuous current, the latter including the resistance. 19 claims.

9,245. "Improvements in electric maximum demand indicators." The British Thomson-Houston Company Limited. (F. P. Cox.) Dated May 2nd, 1899. Current meters.—Maximum demand indicators for multiple wire systems are constructed to be influenced by the currents in all the supply wires except the "neutral wire" so that their indications are proportional to the maximum total load at any time. A thermal overflow instrument for a three-wire supply is illustrated, having two heating coils in the outer wires. Equality and adjustment of effect of the two coils is obtained by shunting them by adjusted resistances. A clockwork indicator may be similarly provided with two coils in the outer wires, acting together to deflect a magnetic needle. An arm of the needle may then make contact with a pin on the indicating pointer of a clock-work, thus closing a circuit containing an electro-magnet, which frees the escapement of the clockwork, allowing it to run until the pointer leaves the arm of the magnetic needle. 7 claims.

9,246. "Improvements in apparatus for measuring electric currents." The British Thomson-Houston Company, Limited. (F. P. Cox.) Dated May 2nd, 1899. Current and energy meters. An ordinary clock motion, having a fan or preferably a self-starting balance escapement, carries a pointer in front of a graduated arc. The pointer is provided with a contact pin. Normally motion is prevented by the escapement lever being stopped by a finger on a shaft, which carries also the heavy iron armature of an electro-magnet. A wattmeter or an ammeter carries an arm into contact with the pin when sufficiently great current or power is transmitted, and a shunt circuit containing the magnet is thus closed. The magnet lifts the armature and frees the escapement, so that the clock runs until the pointer leaves the arm. The pointer then remains where it is until a greater current or power again frees the clock and allows it to move further. It may be set back by hand. 5 claims.

9,272. "Improvements in telegraphing graphic or other matter automatically without wires, and in apparatus therefor." R. Granville-Williams. Dated May 2nd, 1899. Facsimile telegraphs, such as those described in Specifications No. 14,765, A.D. 1894, and No. 6,509, A.D. 1895, are arranged with the transmitting relay attached to the primary of an induction coil, for sending Hertzian radiations from one or more metal surfaces. At the receiving station similar metal surfaces are connected to a coherer, and electro-magnets of which controls the circuits of the recording magnets. The apparatus may be enclosed in metal cases. 1 claim.

9,278. "Improvements in dynamo-electric or electro-dynamic machines." J. G. Statter. Dated May 3rd, 1899. Field magnets. The field magnets of a dynamo or motor are composed of an inner core and an outer core with a magnetising coil arranged in the space between them. Suitably-shaped pole-pieces are brought out on either side of the axis so as to form a space for the revolution of an armature at each end of the machine. Alternatively one pair of pole-pieces may be magnetically short-circuited. 2 claims.

9,351. "Improvements in the manufacture and production of elements for secondary batteries or electric accumulators." H. H. Streeker. Dated May 3rd, 1899. Relates to plates or electrodes in which the active material is in a mass within a frame as distinct from a grid, and consists in removing the central portion of the active material and inserting into the opening thus formed a divided ring or frame, so as to reduce the weight of the electrode, to prevent warping, and to facilitate the circulation of the electrolyte. Positive electrodes of this shape are made of a mixture of litharge and lead carbonate which is slightly moistened by an alkali, and when fitted in the frames are without drying formed in an acidulated salt solution, preferably in an acidulated solution of an alkaline sulphate. 2 claims.

9,367. "An improved process for the production of accumulator plates." A. Lohmann. Dated May 3rd, 1899. Consists in subjecting lead plates to a preliminary formation in an electrolyte consisting of an acid of the fatty group, such as formic, acetic, butyric, lactic, or oxalic acid. The plates are subsequently washed with water and brushed, and are then formed in the usual manner. 1 claim.

9,882. "Improvements in electric lighting apparatus, especially applicable for railway and other vehicles." E. J. Preston and A. B. Gill. Dated May 10th, 1899. Relates to improvements upon the system of train, &c., lighting described in Specifications No. 5,631, A.D. 1894, No. 1,611, A.D. 1895, and No. 6,329, A.D. 1896. A switching arrangement is shown for controlling the number of lights. The current is supplied from a battery or other source, and the lamps are divided into two sets connected to a switch consisting of two drums engaging with contacts. The spindle carrying the drums is rotated by electro-magnetic means controlled by a switch. The contact-faces on the drums are so arranged that one or both sets of lamps may be alight, or both may be extinguished. Several sets of electro-magnets may be employed. In cases in which both batteries are put on parallel, as in Specification No. 6 329, A.D 1896, the resistance is divided into two or more parts, and the circuits are arranged so that only a portion of the resistance is short-circuited. In the general arrangement are the batteries, the divided resistance, the reversing-switch controlled by the centrifugal governor described in Specification No. 5,631, A.D. 1894, and the hand switch for the lamps. Supplementary switch arms are controlled by one of the arms of the switch, and control the connections of the battery and resistances. In lubricating the dynamos, the valves are operated by an electro-magnet placed in the oil reservoir or in a chamber adjacent to it. 8 claims.

9,938. "A new or improved protective conduit for the current conveyers of electric railways." A. Perzenburger and A. Haid. Dated May 11th, 1899. Conduits for the conductors on electric railways are formed, preferably above ground, of metal or other plates curved to an arch form and either bent to engage together at their ends or having recess grooves bent in them to spring round correspondingly arched stay rods. The plates may be attached to the sleepers, or held in position by the rods, which are secured to piles. The conduit may form one or more chambers, a central piece correspondingly dividing the space between the edges of the plates. The conductors are separately supported, and are rubbed by a collector passing through the opening. The opening is preferably closed by hinged and spring flexible flaps, so that the collector opens and closes the slot as it moves along. 5 claims.

9,966. "Improvements in the manufacture of protective casings or tubular structures for electric cables." A. J. Boult. (J. Jungbluth.) Dated May 11th, 1899. Conduits are formed of tubes consisting of a mixture of Trinidad asphalt, powdered unslaked clay lime, Val de Travers asphalt, cement, and coal tar. The ingredients are mixed hot, and are formed into tubes by means of a roller press. 2 claims.

9,989. "Improvements in and relating to the governing of engines used for driving electric generators in electric distributing systems." H. A. Mavor. Dated May 11th, 1899. Relates to the governing of engines used for driving electric generators in electric distributing systems, with the object of varying the engine speed in proportion to the load. In one arrangement the auxiliary centrifugal governor driven by the variable-speed electro-motor, supplied by current from the dynamo, assists the mechanically-driven governor to control the throttle valve or expansion valve of the steam engine. The valve lever is connected to the adjusting or load spring. In a modified arrangement, the auxiliary governor is connected by a rod to the adjusting spring, so that it alters the tension of the spring, and does not impart motion directly to the valve. The method may be applied to oil or gas engines, turbines, and water-wheels, as well as to steam engines. 4 claims.

10,029. "Improvements connected with the controlling of shop windows, illuminating electric lamps, and the like." W. Douglas. Dated May 12th, 1899. Relates to apparatus for lighting and extinguishing electric lamps at predetermined times for shop windows, signs, &c. In the arrangement two clocks are employed for releasing weights at predetermined times. One serves to put a switch "on," and the other to put the second switch "off." The switch arms are fitted with springs which tend to the arm of the "on" switch on to the contacts, and the arm of the "off" away from the contacts. The arms are held against the action of the springs by the levers. When the weight falls it strikes the lever, and allows the arm to complete the circuit. When the weight falls on to the lever the circuit is broken, the contact arm being released. 2 claims.

10,081. "Improvements in electrical resistance." M. Levy. Dated May 12th, 1899. Resistances for regulating the field currents of dynamos, and motor currents on railway vehicles, for arc lamps, or for other purposes, are made up of sections of insulated wire, mounted on separate metal supports, so that they can be replaced if damaged. Each wire may be laid zig-zag in enamel on a ribbed-strip of sheet or cast-iron, and provided with connecting wires. Such strips may be clamped in a rectangular frame by a crossbar and screws, the frame carrying a pivoted switch arm and contacts to which the connecting wires are attached; or the iron supports may be sector-shaped to fit in a circular frame, each support carrying a contact stud. A straight strip may be provided with a slider making contact directly with the wire; ring-shaped supports may be arranged similarly in a circular frame. 2 claims.

10,109. "Improvements in joint-boxes for electrical installations and connections therefor." G. Wilkinson. Dated May 13th, 1899. A junction-box is arranged with an outer metal case provided with brackets for supporting an inner case, and also for clamping the ends of the main conductors which enter the inner casing from below; branch leads similarly enter the inner case. The inner conductors are provided with clamps or may be provided with conducting-hoods surmounting insulating sleeves, a special plate with connecting straps and thimbles being provided to fit on to the hoods. 5 claims.

10,153. "An improved method of controlling mechanisms by means of Hertzian waves." E. Wilson, C. J. Evans, and H. Godsal. Dated May 13th, 1899. In controlling mechanisms by Hertzian radiations, receivers varying in sensibility are employed, and are separately executed by varying the transmitters, or the waves emitted by the transmitter. 4 claims.